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20 January 1983

WEST EUROPE REPORT SCIENCE AND TECHNOLOGY

No. 134

CONTENTS

BIOTECHNOLOGY

Searle To Study, Develop Genetically Engineered Products (INFORMATIONS CHIMIE, Jun/Jul 82)	1
British, French Firms Want Biotechnology Cooperation (BIO--LA LETTRE DES BIOTECHNOLOGIES, Aug 82)	2
Briefs Genetic Engineering in Neurology	4

CHEMICALS

Restructuring of Chemicals Industry Continues With PCUK (Claude Goudier; L'USINE NOUVELLE, 18 Nov 82)	5
--	---

ELECTRONICS

Philips Optical Storage Discs Described (DIE COMPUTER ZEITUNG, 8 Sep 82)	8
Exposition Will Display Innovative FRG Electronics (Heinz Friedberg, Siegfried W. Best; ELEKTRONIK INDUSTRIE, 3 Nov 82)	14
European Semiconductor Industry: Markets, Government Programs (Achim Scharf; ELEKTRONIK-APPLICATION, Sep 82)	29
Briefs How Will 'New AEG' Look	48

ENERGY

First Results, Problems of French Deep Gasification Program (Pierre Gaussens; L'INDUSTRIE DU PETROLE GAZ-CHIMIE, Oct 82)	49
--	----

INDUSTRIAL TECHNOLOGY

Company Formed To Manufacture Laser Machine Tools (Patrick Piernaz; L'USINE NOUVELLE, 28 Oct 82)	62
---	----

TRANSPORTATION

Citroen Uses New Materials, Manufacturing Techniques for BX (Pierre Laperrousaz, et al.; L'USINE NOUVELLE, 30 Sep 82)	64
--	----

Snecma/GE CFM56: Engine for a New Airliner Generation (AEROKURIER; Sep 82)	71
---	----

Briefs

Airbus Flight Simulator	76
ATR-42 Status Report	76
Rolls Royce '10-Ton' Engine	77
Attempt To Commercialize BAe-146	77

BIOTECHNOLOGY

SEARLE TO STUDY, DEVELOP GENETICALLY ENGINEERED PRODUCTS

Paris INFORMATIONS CHIMIE in French Jun/Jul 82 p 79

[Text] G. D. Searle has turned over its High Wycombe plant in Great Britain for pilot research and development of products that can be manufactured through genetic engineering.

At this plant, Searle has emphasized "bacterial culture" rather than tissue culture. This modification stems from the failure of the beta-interferon project, but also from the discovery of peptides that can be produced by recombinant organisms. From now until the end of the year, the company hopes to be able to begin the first clinical trials with one of these products obtained through recombinant DNA techniques following cloning of a synthetic gene in bacteria. It involves a product that has been studied in collaboration with ICI and meant to inhibit gastric secretions.

The plant, which already has several fermenters with a maximum capacity of 450 liters, was designed to contain a 4,000 liter fermenter. With this sort of volume, it is possible to proceed from the pilot stage to the industrial scale. Searle will be able to call on the significant fermentation potential at the Japanese company, Meija Seika, with which it recently signed a technology exchange agreement. In addition to the peptide for counteracting ulcers, the company is arranging for genetic engineering research on interferons. The idea is to produce structural variants having an activity that is higher or more specific than that of natural compounds. These analogues, if discovered, would be produced in bacteria containing synthetic genes.

Finally, Searle is trying to produce aspartame, which is its sweetener consisting of two amino acids. The latter, produced by bacterial fermentation, could be synthesized individually with higher yields by using recombinant organisms.

12234

CSO: 3698/94

BIOTECHNOLOGY

BRITISH, FRENCH FIRMS WANT BIOTECHNOLOGY COOPERATION

Cergy BIO--LA LETTRE DES BIOTECHNOLOGIES in French Aug 82 p 2

[Text] To meet the competition developing outside the European Community in the field of biotechnology, cooperation between the French and British industries may be considered, particularly in sharing development costs and to avoid an overlapping of efforts. Such cooperation could result in joint research and development programs in license or agency agreements (both ways) or in partnership on a third market.

The British Embassy in Paris has details on British firms who want to start exchanges with French partners.

For example a supplier of anti-interferon in rot, of products for diagnostic analysis and of reagents for analysis of blood groups is looking for a distributor and is offering licenses for manufacturing a microbic coagulant needed for making cheese. It is also open to all proposals for a joint operation of industrial conversion treatments.

A very large pharmaceutical company would like to examine the possibility of obtaining licenses on techniques for improving the manufacturing of special existing pharmaceuticals and chemicals or pertaining to new products.

Two companies are looking for partners in the area of genetic engineering reagents and for the development of human hybridone [?] ranges used for producing specific antibodies.

A supplier of tissues and cellular media, making use of growth agents, monoclonal antibodies and plasma proteins is looking for agents in France.

A contractor for treatment stations, making use of monocellular proteins and continuous fermentation processes, would like to establish cooperation with French manufacturers for developing treatment techniques that could be operated under license by third-party firms.

A contractor for alcohol, gasification plants, genetic engineering of yeasts, starch-based products and fermentation processes in general wants to open contacts with French firms for a possible exchange of know-how.

A company dealing in the production of biogas for agro-food industries is looking for a representative to market its support-mounted digesters in France. Another company is looking for a partner to operate its bioenergy system under license.

In the food industry, a very large treatment plant, experienced in using biomass in the production of fungal proteins for human food products and in continuous sterile fermentation, is offering consulting services.

Additional Information: Write to #29 at BIO and your letter will be forwarded (service reserved for our subscribers).

12204

CSO: 3698/61

BIOTECHNOLOGY

BRIEFS

GENETIC ENGINEERING IN NEUROLOGY--Genetic engineering techniques, already widely used in immunology, virology and endocrinology, are making their appearance in neurology. We are indebted to the team of J. Mallet, in charge of research at CNRS [National Center for Scientific Research] at the Institute of Microbiology in Orsay (CNRS #136), for successfully cloning the gene of tyrosine hydroxylase, an enzyme present in nerve transmission in mammals and particularly in man. This genetic approach now makes it possible to study the mechanisms of differentiation of nerve cells (neurons) at the molecular level. It might also enable us to determine the origin of certain neurological and psychiatric disorders. A more detailed article will soon appear in BIO-SCIENCES, a French magazine on applied microbiology and biotechnology. [Text][Cergy BIO--LA LETTRE DES BIOTECHNOLOGIES in French Aug 82 p 7] 12204

CSO: 3698/61

CHEMICALS

RESTRUCTURING OF CHEMICALS INDUSTRY CONTINUES WITH PCUK

Paris L'USINE NOUVELLE in French 18 Nov 82 pp 79-80

[Article by Claude Goudier: "PCUK's Split-Up--And Then What?"]

[Text] The PCUK cake has been sliced in thick slides: one portion for Rhone-Poulenc, one portion for CdF-Chimie [French Coal Industry-Chemicals], one portion for Elf-Aquitaine, through ATO [expansion unknown] and Chloe. But no matter how hard this restructuring may have been, there are still employment problems to be solved and financial means to be found for investing and taking the offensive again.

One of the most difficult cases in the restructuring of French industry, the case of the chemical industry, will be closed between now and the end of this year. The industrial assets of Produits Chimiques Ugine-Kuhlmann (PCUK) [Ugine-Kuhlmann Chemicals], the "chemicals" subsidiary of Pechiney-Ugine-Kuhlmann, are going to be parceled out to four nationalized concerns: Elf-Aquitaine, which will receive close to two-thirds of it, Rhone-Poulenc, CdF-Chimie and EMC [Mining and Chemicals Company]. For the time being, this is only a broad outline that will have to be used by the presidents of the companies involved to propose to the authorities in a few weeks a financial plan and an employment program.

We are far from the initial project, which, as one recalls, called for the almost complete takeover of PCUK's assets by Elf-Aquitaine, a project that drove Albin Chalandon, president and chief executive officer of Elf-Aquitaine, to throw in the sponge in early July. He was not interested in that chemicals business; the huge expenses brought about by that operation caused him great misgivings. He let this be known, stressing the fact that refining was already quite a heavy burden for Elf. On the other hand, two other chemical conglomerates, Rhone-Poulenc and CdF-Chimie, were interested in some of the 25 locations where PCUK has operations. New discussions took place this summer; they have just resulted in a complete dispersal of the operations that still remained at PCUK after the transfer of its dyestuffs to the British ICI in October; that is, halogen chemistry, inorganic chemistry, organic chemistry and plastics.

- Elf-Aquitaine, as can be seen on the map (see p 80) [not reproduced] receives a very big share of the PCUK production plants involved in halogen chemistry (chlorine, fluorine, bromine and their derivatives), in organic chemistry and in inorganic chemistry. To this are added the operations concerning "plastics" derived from the chlorine chain (PVC) and some production plants abroad. Even though a good number of these plants are rather old, some of them, fortunately, have very modern installations, such as one, started up in 1980, that produces vinyl chloride monomer at Port-de-Bouc--a plant of which Shell-Chimie [Shell Chemicals] owns 60 percent and PCUK 40 percent; PCUK supplies the chlorine and Shell the ethylene.

Albin Chalandon inherits among others the Pierre-Benite (Rhône) installation which uses a lot of fluorine chemistry; it produces sulfuric acid and acrolein. This installation was of great interest to Rhône-Poulenc since sulfuric acid is needed by the conglomerate for its production of plant-care chemicals (acrolein is an intermediate in the synthesis of methionine, one of Rhône-Poulenc's leading products for animal feeds). Moreover, the conglomerate is involved in the special-product part of fluorine chemistry. But it will have to do without it. In exchange, it gets the TDI [toluene diisocyanate] plant that Elf wanted badly.

However, the authorities have asked Elf to agree with Rhône-Poulenc before the end of this year on a strategy that would allow Rhône-Poulenc, already involved in chlorine (Pont-de-Claix) and fluorine (Salindres) chemistries, to operate without being hindered in its development of these branches.

Elf and Rhône-Poulenc Are Asked to Reach an Agreement

- Rhône-Poulenc, which is trying to strengthen its position in inorganic chemistry, will receive three production plants, one of which is located in Belgium. La Madeleine (Nord) takes on a special importance; located in the immediate suburbs of Lille, it spreads over 37 hectares and makes nitrogen and sulfur derivatives and mostly TDI. TDI is a raw material for polyurethane, a plastic used for automobiles, furniture and shoes. Rhône-Poulenc, which was already making some TDI, becomes its sole national producer. On the other hand, the Wattrelos plant, which produces phosphoric acid, does not have much of a future. It may have to be closed since it is an old facility (1905).

The conglomerate also acquires the plant-care chemicals production of Sedagri, a PCUK subsidiary, and Pharmuka, a group of laboratories controlled by PUK. As for the latter, this is a surprise since initially this pharmaceutical firm had not been included in the negotiations. Rhône-Poulenc is receiving there a nice group of laboratories (Fr 757 million gross revenues last year, 31 percent from new products) for its "health" division. Approximately 15 compounds are being developed at the moment.

- As for CdF-Chimie, it strengthens its organic chemistry and its "plastics" activities through somewhat complementary acquisitions.

Thus, in the east, two production plants are close to its Carling petrochemical installation and one of them, at Dieuze, has the largest production capacity in the world for barium chloride (purification of electrolytic baths and case-hardening of metals). With these acquisitions, CdF-Chimie becomes among other things a manufacturer of ABS resin, a top-of-the-line plastic used for automobiles and domestic appliances, and of polyester resins.

In addition--the second surprise of these negotiations--CdF-Chimie receives from PUK its Lorilleux-Lefranc subsidiary, the fifth European producer of printing inks (Fr 750 million gross revenues in 1981). As a result, the Charbonnages [Coal Industry] subsidiary, which had a small "ink" production in its Ripolin-Georget "paints" division, will change its size.

- EMC (Mining and Chemicals Company) acquires the Loos plant. This was the first plant built by Frederic Kuhlmann (1825). It makes chlorinated products (bleach), soda detergents and ammonium chloride. This facility was already working with EMC for Potasses d'Alsace [Alsatian Potash].

Since in the end PUK's chemical industry has been sold "piecemeal" (a fact that PCUK personnel do not very much like), its days are now over. There will remain in France only three big chemical conglomerates: Rhone-Poulenc, CdF-Chimie and the chemicals part of Elf-Aquitaine consolidated around ATO and Chloe, and one medium-sized company, EMC. The restructuring also changes the outlines of PUK; after relinquishing its steels, then its chemicals, PUK is left concentrating on nonferrous products and finds its gross revenues decreased by 30 percent (see Jean Roume's article, p 81).

Personnel Cuts and Plant Closings

But the chemists have not seen the end of their troubles yet. There are still some obstacles to overcome and some of them will be difficult: the projected withdrawal of Total from ATO-Chloe, accompanied by a proper compensation; the financial structuring of these transactions, at the moment still wrapped in a thick fog (PCUK's losses in 1981 topped Fr 880 million, and they must be wiped off...). Finally, the problems related to employment. Thus, personnel cuts are to be expected at PCUK's headquarters as well as in the production plants, since some of them will have to be closed.

It has taken a long time to generate this restructuring and a lot of time has been lost. It will be necessary to take the offensive again and therefore to invest. Does the stockholding state have the means to do that?

12260

CSO: 3698/90

ELECTRONICS

PHILIPS OPTICAL STORAGE DISCS DESCRIBED

Leinfelden-Echterdingen DIE COMPUTER ZEITUNG in German 8 Sep 82 pp 5, 6, 8

[Excerpt from the special publication, PHILIPS IM BUERO; in the section "Mass Storage"; "Response to Market Demands: Capacity Bottlenecks Eliminated by the Optical Storage Disk"]

[Text] More and more demands have been made on the capacity of storage media now available on the market. Also, the sphere of information storage, management and retrieval is assuming greater and greater importance, much more intensely than in the past.

Additional requirements have therefore been levied on new storage media: higher storage capacity than today's magnetic disk systems, distinctly improved price/performance ratio compared to today's mass storage units, capability of filing the new medium and rapid and random direct access. Philips' response to these demands is the optical storage disk (DOR: digital optical recorder).

Research on optical recording methods began in 1972. The first result was the video long play (VLP) disk, which has been on the American market since December 1978. Capitalizing on this basic research, developers broadened their efforts to extend this new storage technology to information processing systems. The product of this multidiscipline research is the optical storage disk on which 1.25 billion bytes can already be stored per 12-inch diameter disk. That corresponds to some 500,000 written DIN 4 A [German Industrial Standard] pages, which incidentally is equivalent to about 2.5 tons of paper. It is also possible to integrate and maintain in direct access several of these disks in a so-called megadoc system so that about 60 billion characters can be stored in such a removable disk unit. The optical storage disk consists of a transparent and unbreakable base on which a thin storage coating is applied. The data to be stored are burnt into this storage layer by a laser beam and can be read as often as desired or else declared invalid. For technological reasons, writing over data, as is done with present magnetic disks, is not possible.

The Philips research and development achievement is perhaps best illustrated by this example:

From a gas laser apparatus that just a few years ago measured 10 meters, a semiconductor laser the size of a matchbox has been developed. This was the essential

breakthrough needed to apply this new technology to future information processing systems, Therefore, the topic is for Philips a 10 year plan. And here are some milestones:

- five prototypes are now in practical use in various research and development projects

- In 1982 and 1983, five pilot projects are to be implemented in the Federal Republic to obtain additional directions for improvement possibilities with regard to user interfaces and peripherals during user testing of the entire system.

- Operating installations of self-contained Philips systems with the optical storage disk as information storage and retrieval systems including a comprehensive data bank system are planned starting in 1984.

Some commercial data that should not be omitted in this connection:

- By the beginning of the advance series, more than 100 million marks will have been invested in the research and development [R&D] project

- Present estimates call for an investment of still another 50 to 100 manyears for all the remaining software development

- The expected price of the data storage medium, thus the disk proper, will be about 800 marks in 1984 and is therefore comparable to current magnetic disk prices for about a 40-megabyte storage capacity

- The price of a read/write station is expected to be about 250,000 to 300,000 marks in 1984, but is also expected to decline to about 100,000 marks after several years in series production.

It must be pointed out here that no general use of current storage media with the optical storage disk is possible; rather, the disk should be considered a complement. Philips is proceeding on the basis that there are further storage heirarchies in which the optical storage disk is just a level, albeit a very important one. The firm believes that the optical storage disk is an innovation for the use of future computer systems, that it will permanently change information processing in business and administration and help cope with the information flood in a simpler and reliable way. A spokesman says the firm is certain that the optical storage disk together with integrated information and communication systems helps organize existing daily routines efficiently and reliable, make information available selectively and in a concentration in accordance with one's own choice at the time and in the form desired, improve information exchange and, all in all, raise the efficiency of modern administrative work.

Up to now, number crunching has been the main activity in information processing and this will remain so in the foreseeable future, at least quantitatively.

Text processing is growing in importance and in the scope and degree of developing close ties to data processing. Image processing will be a next step as well.

This sphere of information processing with the sub-areas of data, text and image processing will be increasingly enlarged by methods of communication with and between such systems.

Information management will also assume growing importance. Up to now, the emphasis has been concentrated heavily on processing units with the greatest performance possible on the one hand, and on the other, on microprocessors to reduce costs.

Without wishing to belittle the importance of pure processing, an increasing emphasis will have to be placed on information management in future.

Substantially higher demands will be imposed on storage for such systems as data banks for consistent and timely data management, for image banks in the field of medical diagnostics, and also for image libraries for agencies, industry, the press and identification systems, etc.

High storage capacity, fast access time, and library filing capability are the requirements imposed on storage that have already been met today. But not exhaustively. Thus, the aims of

- storage capacity higher than that of magnetic disks
- for this capacity, an access time under 0.5 second
- library filing capability of this medium
- and a distinctly improved price/performance ratio compared to current mass storage

have become in their entirety the spur to develop a new storage technology. The optical storage disk, developed by Philips on the basis of the video long play disk referred to earlier, for application in information processing equipment contains 45,000 tracks X 128 sectors. Thus, there are some 5 million such sectors and each sector can store 1,000 bits. This is a net specification for a user. Sector formatting and addressing as well as redundancy for the error detection and correction techniques have already been taken into account.

Each of these some 5 million sectors can be randomly accessed for writing or reading. The disk is made of a transparent base that is about 1 millimeter thick.

Applied to this base is a very thin coating containing tellurium that is 300 Å thick. Three types of information are placed on the disk surface. First, address information in the form of an impression in the disk is placed at the beginning of each sector to divide the surface into sectors.

This impression is made during disk manufacture. Then the sector area is available for burning in holes by using a sharply pencilled laser beam. The burned-in holes have a diameter of 1 μ and are spaced about 2 μ apart. Since the burned-in holes of 1 μ and a 2 μ space are spread out up to ten thousand times in all directions on the disk surface, the desire for a certain principle of order is understandable. This is implemented by recording the holes along a previously impressed track. This track, impressed in the surface during disk manufacture, can be optically recognized and is used as directing information along the sectors.

Fig. 4 [not reproduced] shows a microscopic photograph of the surface where one can see the impressed address information on the left and the directing grooves along which the burned-in holes are clearly recognizable as well. Fig. 5 shows a section in the radial direction. The impressed groove along which the sectors are placed is recognizable.

The circle is used as the target area for the optical read/write device.

The point light diameter is 1 μm. The wavelength of the light used is 0.86 μm. This shows that operations using diffraction optics approaching the limit of physics

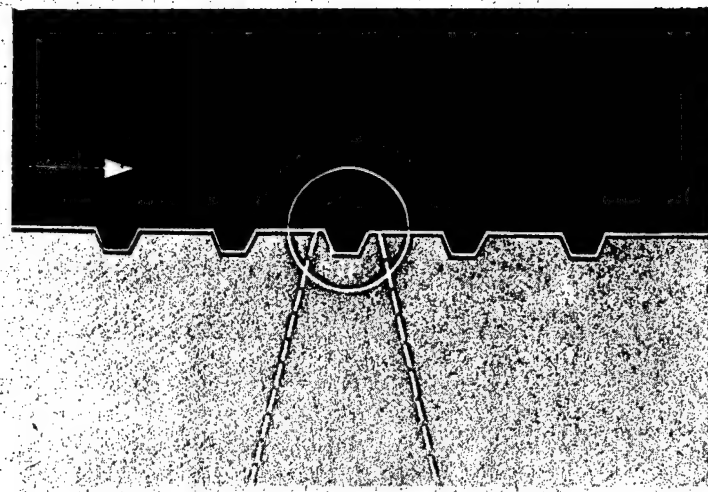


Fig. 5. Impressed grooves along the sectors

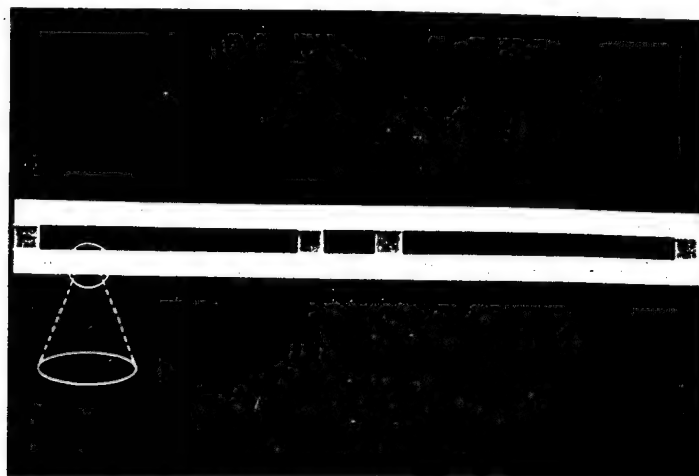


Fig. 6. Two transparent bases with the indicated coating

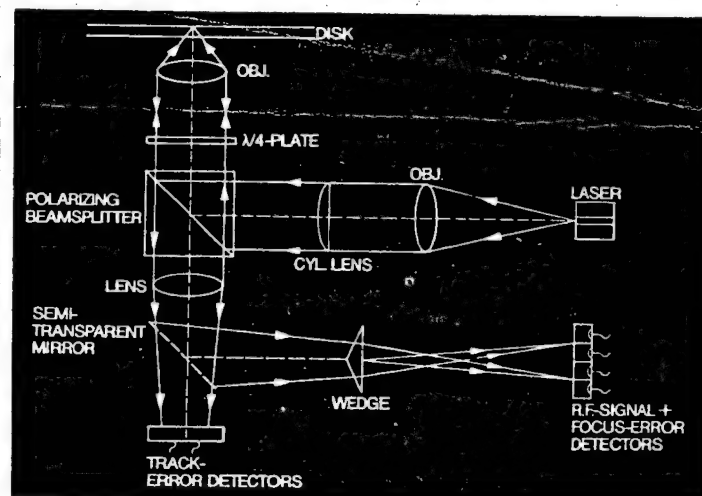


Fig. 7. Schematic representation of optical read/write device

are required here. The depth of focus of the optics is about 1 μm . Disk fluctuations in the axial direction during operation are about 100 to 500 μm . This indicates the enhanced requirements imposed on the automatic sharp focusing and the track follower.

Fig. 6 shows the mounting plates of the overall design. Two transparent bases with the indicated coating are put together as a double disk so that the storage layer is inside in a space protected against dust, fingerprints on the surface, and atmospheric effects. A number of defilements outside of the optical zone of sharpness can be tolerated by the low depth of focus of the optics--about 1 μm --and the disk thickness--about 1 mm.

The clearance between the optics and the storage plane is about 2 mm, which precludes mechanical danger to the disk from the read/write device in operation.

The total capacity of this disk is $2 \times 5 \times 10^9$ bits. Storage capacity of 10^{10} bits on a disk with a diameter of 30 centimeters means a very significant increase in storage density combined with the machine-access capability to this high storage capacity.

All the complicated technology has been placed not in the disk, but in the accompanying system that works with this disk.

Fig. 7 shows schematically the optical read/write device. Four main functions should be mentioned:

- The light source is a semiconductor laser, the light beam of which is concentrated to a focal point at the storage layer plane. This produces the energy needed for writing and the geometric density of information as well.
- The reflected light is used for automatic adjustment of track following,
- for automatic sharp focusing,
- and for forming the read signal.

The entire optics is placed in a small read/write head weighing some 40 grams. This relatively small and light read/write head sits on a positioning mechanism that enables random access.

Fig. 9 [not reproduced] shows the positioning mechanism with the read/write head as well as the disk and its rotary drive as the entire optical-mechanical storage device. This can easily be expanded by a stack of disks which together with an automatic feed device enables a considerable multiplication of the 10^{10} bits.

Optical recording methods in the form of light/dark or hole/no-hole contrasts are not new; in fact, they are among the oldest recording methods. The novelty of this technique lies, however, not in the principle, but in the very refined and highly evolved technology.

In this case, the specialties of

- optics
- thin-film technology
- precision technology
- automatic control technology

--and semiconductor lasers

had to be combined each in a highly developed form. Philips' advantage was that all these specialties are available in house.

Will the new optical storage disk replace other information media like paper and magnetic disks?

Absolutely not. The optimal dimensioning of a storage hierarchy will remain in the appropriate combination of several storage techniques.

The optical storage disk, by its high capacity, opens the possibility of storing not just alphanumeric, but also image information in a cost-effective way. The demand for system direct-access to the total storage capacity, which is growing with communication methods, can also be met by using the optical storage disk. Existing functions can be improved and new functions can be developed in future.

8545

CSO: 3698/108

ELECTRONICS

EXPOSITION WILL DISPLAY INNOVATIVE FRG ELECTRONICS

Heidelberg ELEKTRONIK INDUSTRIE in German 3 Nov 82 pp 12,13,15,18,23,24,26,28

[Article by Heinz Friedberg and Siegfried W. Best]

[Excerpt] In a few days, the electronica will begin for the tenth time at the Munich Exhibition Grounds. Even before this anniversary, it became clear that the electronica is by far the most important event for the manufacturers and users of electronic components. The fact that this international technical exhibition for electronic components and subassemblies has become so successful precisely in the Federal Republic, is not based only on clever exhibition management. The Federal Republic is indeed the most important European market for electronics as a whole.

Initiated by distributors and smaller companies, which formerly attempted in vain to find space in Hannover, and ridiculed by the giants of the industry when it was initially held in 1964 in two halls, it was even then a success for the participants. A success for exhibitors and visitors. A success which quickly became known, which acted as a multiplier, and which long ago drove the number of exhibitors and visitors right to the capacity limit. About 1050 exhibitors are present this year, presenting their own products and the products of more than 750 other represented companies. We expect about 85,000 visitors from about 60 countries, presumably a quarter of these from abroad. Dr. Eng. Georg Spinner, Chairman of the Electronic Technical Committee, has appropriately characterized the essence of this exhibition: "The electronica is a technical information exhibit with discussion between the engineers of the exhibitor and of the user. It is important for the exhibitors to discover the trends of customer requirements. For the user, it is an information forum concerning technical innovations."

A document of the German Federal government estimates that about 600 billion DM of the present sales of German industry and more than 50 percent of its exports are directly influenced by electronics. The fact that this influence continues to rise is due to the high innovation pressure which starts from progress in microelectronics components. Microelectronics and the availability of corresponding components thus has a key significance for the development of industry as

a whole. This appears clearly, for instance, in machine construction. Here, export has shifted in favor of those machines which have a significant electronic component. The same is true in automobile construction and in the electrical engineering industry (1979 exports: 30.9 billion DM), where data and communications technology, measurement, control, and regulation technology, which depend most on microelectronics, have recorded the highest growth rates.

The necessity of strong domestic component manufacturers, so to speak as producers of the "raw materials" for all electronic circuits, thereby becomes clear.

The Americans and the Japanese have known this for a long time. They emphatically promote basic research and product development and are setting up production sites and development centers in other countries, including the Federal Republic. Proximity to markets is the argument, i.e. to react quickly to market requirements in close collaboration with the users, and to make available at an early stage advanced and powerful components.

In metropolitan Munich, one finds a concentration of important semiconductor firms, a German silicon valley. Siemens in Munich and Regensburg, Eurosil in Eching, and Texas Instruments in Freising were the first. Finally, Hitachi with its plant in Landslut, SGS Ates with its development center in Grafing, and recently, Fairchild in Wasserburg have capitalized on this potential.

The four giants

AEG Telefunken, Intermetall, Siemens, and Valvo are the big names in the German semiconductor industry. Through market-oriented product innovations based on their own basic development, all four have achieved many international top performances over the years. Here, one calls to mind the method for drawing highly pure silicon single crystals, which was developed by Siemens, or the world-wide leading position of Intermetall in signal and zener diodes. Even an only approximately complete survey would exceed by far the scope of this report; still, a few especially noteworthy research areas will be illuminated and top products will be presented.

In Heilbronn AEG Telefunken manufactures the solar cells for numerous research and communication satellites. In the Wedel plant, and partly also at MBB, these were used to equip the solar generators which unfolded in space after starting. Heilbronn also leads in polycrystalline cells for terrestrial use. Altogether, optoelectronics is the strength of this plant. Besides LEDs in numerous versions, optical couplers and V-groove laser diodes are also fabricated. The production line for the V-groove lasers was built up in 1981. Ten standard types with output powers of 5...20 mW and wavelengths from 790...830 nm are being exhibited at the electronica. A rapidly rising demand is expected for optical transmission and for video disk playback machines. Laser diodes, however, are also used in optical memories and electro-optic printers.

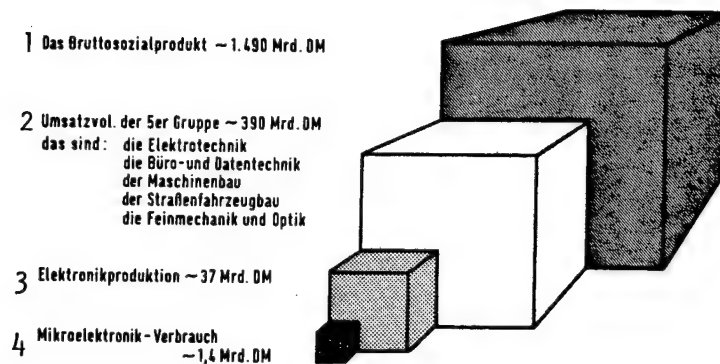


Figure 1. The influence of microelectronics on the national economy of the FRG. Numerical data for 1980 (Picture: Valvo)

- 1 gross national product ~ 1,490 billion DM
- 2 sales volume of the five groups ~ 390 billion DM, this includes:
electrical engineering
office and data technology
machine construction
road vehicle construction
fine mechanics and optics
- 3 electronics production ~ 37 billion DM
- 4 microelectronics consumption ~ 1.4 billion DM

Since 1 November, Heilbronn is the headquarters of Telefunken Electronic GmbH, which was jointly founded by AEG Telefunken Inc. and United Technologies Corp., and which has taken over the production program of opto and individual semiconductor components of AEG Telefunken. The cooperation contract includes the foundation of another corporation: The Telemos Electronic will concentrate on the development and production of custom-specific components based NMOS and CMOS gate arrays.

Intermetall's strategy is to concentrate on certain market segments, in order to achieve a leading position in these sectors. The company is world wide the largest manufacturer of signal and zener diodes and an important supplier for small rectifiers (about 650 million units in 1982). At the electronica, an MELF housing for diodes and zener diodes is being presented by means of which these components become suitable for automatic ship equipment of circuit boards.

As regards T0-92 transistors, Intermetall, with about 750 million units, is the largest manufacturer in Germany and has a market fraction of more than 40 percent.

Its fraction of the world market is about 6 percent. Whether this also puts Intermetall on top world-wide cannot be said exactly since no figures are available from several Far-East manufacturers, but the plant undoubtedly is among the three largest. Following the general trend to miniaturization, the company will shortly also offer its transistors in the miniature housing SOT-23.

Altogether, Intermetall in 1982 will produce more than 3.5 billion discrete semiconductors. These will have about the same total value as the 110 million ICs which will be produced in this year. Both with transistors and also with the ICs, the Freiburg company has striven for automation from the very beginning. Instead of going into low-wage countries, automatic chip and wire bonders were developed in-house, of which the second generation operates today. These do not only work economically, but also work with a uniformity that cannot be achieved manually.

As regards ICs, Intermetall concentrated on areas with large numbers of units: radio and television units, watches, motor vehicle electronics, telephone technology. The speech synthesizers (elektronik industrie (Electronic Industry) Vol. 6, 1982, p. 6), the microcomputer SAA 6000 (elektronik industrie, Vol. 2, 1980, p. 11) and the IC for digital signal processing in television receivers, to be discussed later, are outstanding here.

Siemens probably has the most manifold offering among the German semiconductor manufacturers. From diodes and rectifiers to the highest powers, through ICs of all types, up to microwave components, the production program is a very extensive one. With the broadband amplifiers CGY 21 for 40...860 MHz or respectively CGY 31 (up to 3 GHz), Siemens is the first manufacturer in the world to deliver mass-produced ICs of GaAs. The new, low-noise GaAs FETs (0.5 μ m gate) CFY 15 and CFY 16 can be seen at the *electronica*; also two 12/1 GHz converters for satellite television. The SMC 98 127 converts - for OTS - 11.58...11.70 GHz into the range of 800 MHz; the SMC 98 129 converts - for TV-SAT - 11.70...12.5 GHz to 0.95...1.75 GHz. Both have a two-stage preamplifier with CFY 15, followed by a balanced Schottky mixer. The CFY 13 is used in a dielectrically stabilized oscillator, as the high-linearity output stage of the integrated amplifier CGY 31. Up to 6 GHz, Siemens is now working with silicon. With a 0.8 μ m geometry, the bipolar BFQ 77 is an economical alternative to GaAs up to about 4 GHz. Self-adjusting masks, ion implantation, and multi-layer metallization were used here. It has an additional passivation - as was the case, until a short time ago, for all Si microwave transistors from Siemens. The chips are hermetically sealed with low-pressure nitride (Si_3N_4); only the connection contacts remain free. Influences from moisture and the environment are considerably reduced.

Siemens was really successful with power MOS. SIPMOS (Siemens Power MOS) is one of the top technologies for MOS power FETs. After initial problems at very high voltages, types up to 1000 V are now available from mass production in the Munich-Freimann plant. As a world novelty, the BZU 11 A (limit value 50 V/25 A) is being exhibited at the *electronica*, a type with the previously unachievable inherent resistance of only 0.06 ohms. Also presented are the BUZ 50B with 8 ohms at 1000 V/25 A and the T0-92 BSS100 and 101 with I_{DSS} (expansion unknown) less than 200 mA at 60 V. SIPMOS transistors in the T0-238s were already introduced at the Geneva Powercon 82. This internally insulated plastic housing (test voltage 12.5 kV) has leakage paths according to the VDE 0110. Flat-plug connections

at the upper side facilitate assembly.

Another focal point of the power components of Siemens is Shottky diodes and rectifiers. These are used in switching regulators, DC converters, motor controls, etc., especially when optimum efficiency is required with low working voltages and high working frequencies. With an integrated guard ring, which limits the voltage in a manner similar to a zener diode connected in parallel, and which protects against transients, a blocking voltage up to 60 V is achieved. There were individual diodes for currents up to 75 A, double diodes up to 2 x 30 A.

Valvo surprised the electronica with a production-ready silicon image sensor in resistive gate technology. The RGS image sensor has 300 lines, each with 200 elements, which are read out interlinearly, the first half image directly, the second half image by forming averages of the charges on neighboring lines. This generates a flicker-free image of 60,000 image points. The image elements of the sensor (crystal area 5.5 x 7.5 mm²) measure 14 x 28 µm² (light sensitive portion 14 x 6 µm²). The image diagonal of 7 mm corresponds to Super-8 so that commercial lenses can be used. Besides the good overall sensitivity, its high blue sensitivity should be emphasized. Its essential advantages are small dimensions and low weight, high shock and vibration strength, insensitivity to interference fields, high burn-in strength, long lifetime, low operating voltages, and low power consumption. Six hundred and twenty-five lines, such as are required for video cameras, are not possible with the RGS principle at the present state of the art. But Valvo sees many applications for which the RGS image sensor will suffice: House-door and other monitoring cameras, electronic rear-view mirrors for trucks, sensors for power recognition, etc. After mass production starts up, Valvo would like to attain prices which are comparable to those for Vidicons. With the relatively small chip size that is required for an image sensor, this does not appear unrealistic.

The microprocessors

Through a technology exchange with Intel, Valvo obtained access to the single-chip µP family 8048 and, as a further development, brought out the family MAB 8400. As the most noteworthy innovation, it has the I²C bus (inter-IC bus), an economically handling serial interface based on internal series/parallel or parallel/series conversion. The CMOS processor family PCF 8500 is also equipped with the same interface and other wise is also essentially instruction-compatible. This unit and the I²C bus will be discussed in more detail elsewhere in this issue. With 16 bit processors, Valvo can base itself on a long term development contract with Motorola for the 68000 family. The VME bus was developed jointly with Motorola and Mostek. Its essential properties with the first 16 bit plate developed at the VME bus are described on page 51.

As regards microprocessors, Siemens has a cooperation agreement with Intel. They began with the 8080, expanded to the 8085 and the 8086 (which today accounts for 80 percent of the number of units and two thirds of the new developments), to the new family iAPX 186 (elektronik industrie Vol. 6-82, page 46), iAPX 286 (elektronik industrie 3-82, page 53), and the iAPX 386, which has been announced for 1984. But in this area, Siemens can also present considerable developments of its own. The SAB 80 199 is being presented at the electronica. This is a 16 bit

microprocessor, whose architecture differs significantly from conventional components, and which helps to save considerable programming effort. The 45 mm² large chip contains not only the CPU, but also the most important functions of a real-time operating system.

The SAB 80 199 is designed for critical real-time jobs. The instruction cycle is only 0.5 μ s. It uses a new instruction set, but is bus-compatible with the 8086. Models of the SAB 80 199, produced with 40,000 transistor functions in 3 μ m structure, have been announced for the second quarter of 1983. Until then, there is an evaluation kit for the development system SME.

The DMA switching circuit SAB 82 258 was developed as a peripheral module for the 8086, 8088, 80186, and 80286. This makes possible transmission rates up to mbytes per second with an addressing range and a maximum block length of 16 mbytes. The circuit can also perform search and comparison functions. For flicker-free monitor images in text processing systems, the image point generator SAB 82 731 operates with an image point rate of 80 MHz. Constructed internally in the ECL, the bipolar module has TTL-compatible connections. It makes possible various character widths up to 16 grid points, rounded characters and double character width. Its control functions include blinking, inverted display, and tabulator settings. The SAB 82 731 is compatible with a text-oriented CRT controller of the next generation by Intel.

Especially for telephone terminal devices, Siemens is presenting at the electronica 82 its CMOS- μ C SAB 80C482. It works beginning at 2.5 V and, at 5 V and 1 MHz pulsing, requires only 1 mA, and in standby less than 15 μ A. On one chip, it offers static standby, direct interrogation up to 64 keys, 2 kbyte ROM, 64 byte Ram, timer and counter functions. The CMOS RAM SAB 81C50 with 256 bytes is available for storage expansion.

The specialists

An extremely power-saving CMOS process is also the basis of Eurosil products. This company was founded in 1971 in Munich and has recently moved to a new building in Eching. In 1977, it introduced the first CMOS wrist watches- μ P. Today, Eurosil has 200 employees and concentrates on working out complete problem and function solutions in collaboration with the users. Progressive watch- μ Ps are available for this, which can be programmed at the PAL level with the most various play functions. The ICs are fabricated in Eching, are assembled in the far East, and are again tested in Eching. The installation of automated assembly is planned in Eching. The performance capability of this relatively small company becomes clear when one discovers that, for ICs for simple watches (3 1/2 digit LCD display, five functions) it has a market volume of 110 million units, which represents a good market fraction as compared to its Far East competition.

The single-chip μ P e3101, which now is ready for production (chip size 36 mm², 6 μ m technology), and which operates with voltages beginning at 1.5 volts, represents a powerful component for battery-operated devices. Eurosil sees applications in hand controllers/terminals, as display controller in telephone equipment with LCD displays, in connection with electronic acquisition of heating costs, and similar tasks.

In the future, Eurosil will develop more standard products, in which the power-saving CMOS process is advantageous. Here one thinks of applications in automobile electronics, dialing ICs, codecs, filters, and extremely low-power RAMs for the telecommunications area. There is close collaboration with the Heinrich Hertz Institute and several colleges.

Another example of successful microelectronics activities is the Prema located in Mainz. The company could not find the optimal ICs on the market for its measuring units. Therefore, in 1980, it started its own development. In the meantime, it also works for external customers and has successfully concluded a series of integration projects. Prema is a specialist for customer switching circuits even in small numbers of units, and has filed the only responsibility claim of semiconductor manufacturers for an IC design. The design of integrated circuits was made accessible to the user; thus, customer ICs can be economically developed and produced even in the range of 10,000 units.

Chip prototypes (full custom design) are delivered about four weeks after delivery of a data tape, for a price of DM 7000. Previously this price level was not even reached with gate arrays. It makes it possible for the circuit developer to perform test runs and to make test circuits, even at a preliminary stage to the final product. The IC know-how for standard processes, which is required for design with basic cells, can easily be transferred to the customer. Part of this know-how transfer is a newly published manual on the user-oriented IC development, in which Prema communicates the foundations of bipolar circuit integration within 250 pages, and describes the available library elements as the basic building blocks of custom specific cell design. As a point of wonder, one should mention the entry risks and costs for a broad group of users. This can be estimated, however, with careful preparation.

The Cerleds are another example of the creativity of smaller enterprises. Elcos GmbH in Pfaffenhofen offers these LED chips on ceramic ports, by means of which the user can produce LED displays of all types himself, without special tools. This support of Al_2O_3 has a conducting coating on four sides and, on its upper side, carries the LED chip, which is protected by an epoxy lens. This structure has greater heat compatibility than "standard" LEDs. The component can be soldered directly on conductor strips, pins, or receptacles by hand or in the reflow method, or it can be affixed with conducting glue. For automatic attachment, these novel components, which are available in the colors orange, green, yellow, yellow-green, infrared, and also as phototransistors, are delivered in magazines or on the Super-8 belt.

But the microelectronics activities in German industry goes still further: Klöckner-Müller is known world-wide for its switching units. Recently, it has built up its own semiconductor production. The background for this was to have its own base for future developments in the area of industrial electronics, to develop semiconductors particularly for specific needs. In the pilot line, which was set up in 1978, one can run most processes from bipolar to silicon-gate-MOS technology. Bipolar power transistors and MOS FETs are already being produced. At the beginning of 1983 will follow the first integrated circuits (CMOS-AD converters) and gate arrays.

Figure 8

The ion implantation system of the semiconductor pilot line which has been set up in the central research area of Klöckner-Möller. It is supposed to develop semiconductors specifically for in-house needs and will itself produce them in rather small numbers of units.

Hybrid technology

Thick-layer and thin-layer circuits are used when monolithic integration is not possible with the present state of the art, or when monolithic integration is not profitable because the numbers of units are too small, but when small dimensions and/or high reliability are required. A whole series of German companies have their own hybrid production lines, and a few have specialized entirely in this area.

Andreas Lewicki in Oberdischingen at Ulm regards itself as the German expert for high-rel hybrid ICs. Hybrid ICs or also ceramic multichip multilayer (called KMM) are chips of integrated circuits, which are built up on ceramic multilayers, and which fulfill and even exceed the most stringent quality requirements of the military, of space travel, nuclear technology, and medicine (human implants) (e.g. MIL STD 883 and MIL-M 38510).

Compared to conventional multilayers, the KMMs have a large number of advantages: smaller (e.g. 1/20th of the volume and 1/15th of the weight), more reliable, and more economical. They are fabricated in the thick film screen printing technology with noble metal conductor strips. The number of layers is nearly unlimited. Through-contactings are possible without holes or additional metallizations. Naturally, the KMMs can also be printed with highly stable thick-film resistors. On the sintered noble metal KMMs, unencapsulated chips can also be bonded. In this way, one third of the critical contact points are obviated. The small KMMs can also have hermetically sealing protective glazes smelted on them, for maximum reliability requirements. To protect the semiconductor chips, they can be hermetically soldered or welded into metallic or ceramic capsules.

The microelectronics of Rohde and Schwarz develops and produces hybrid circuits, in accord with customer wishes, for applications in industry, data technology, commercial electronics, defense technology, space travel, and medicine. Hybrids in thin and thick layers are used, chip-and-wire as well as soldered components. Chips of all types, microsemiconductors such as the SOT-23, SOT-89, etc., or chip carriers in various technologies are applied as components: soldering, gluing, welding and bonding. Figure 9 shows a fast pulse amplifier with a bipolar differential input from a series of highly reliable hybrid circuits in the hermetically tight flat packed housing for space research.

Gate arrays

As already mentioned, Telefunken and UTC with their new electronic subsidiary Telemos will also enter into the production of gate arrays. A big future is predicted for these semi-customer ICs. Market studies forecast the fraction of gate arrays in the IC market for 1986-1990 sometimes at 10 percent, sometime as high as

50 percent. The principle of gate arrays is not new, but only modern designs and computer-supported layouts of the customer mask have recently lead to a breakthrough to acceptable prices.

Valvo estimates the market fraction of the gate arrays for 1986 at 14 percent of the logic market, and specifies that they make possible more economical solutions than the standard SSI/MSI even beginning at 2000 units. In Hamburg, a CAD design center was recently equipped. According to the experience and knowledge of the customer, this can take over the integration process in various stages of development. Valvo has available four families of gate arrays in CMOS, LS-TTL, and ECL technology (elektronik industrie 10-82, page 3). Also in preparation are advanced developments of ECL arrays with 600...2200 gates and only 0.35 ns delay time, faster CMOS arrays with 1.5 ns, and, in the LS-TTL family, types with 1600 and 2100 gates. These can fulfill the requirements of all present applications.

Digital television

Much has been written and still more has been speculated concerning the IC system for digital signal processing in television, which was presented for the first time by Intermetall at the broadcasting exhibition of 1981. Now the ICs are ready, and by the end of the year mass production will be started in Freiburg. Lubo Micic, director of ITT Semiconductor, knows that this system thus has a four year lead, since competitors only noticed it in the previous year, when development was already far advanced at Intermetall: "And they will need as long as we did to develop the system definition and the hardware."

Very early, Intermetall concerned itself with the question where the technology of very high integration, perhaps with more than a million functions per chip, can be suitably applied. They reached the conclusion that the price per gate will then become so favorable that certain applications will become possible for the first time. Rüdiger Karnatzki, director for IC products in Freiburg, sees the necessary unit numbers for this, however, only in the consumer area, that is in entertainment electronics, telephones, autos. Because of its comprehensive TV knowhow, the "digital television" was attacked first. Intermetall developed the ICs for digital TV signal processing in close contact with a "user's club" of significant German, European, American, and Japanese device manufacturers. They are based on the principle of real-time signal processing, or expressed more simply, a new type of microprocessor with architecture which, in modern NMOS technology, is fast enough to process video signals in real time. "We did not invent the signal processor," says Rüdiger Karnatzki, "but we adapted it for optimized problem solutions in a certain area." Because of their high speeds, the signal processors can calculate the coefficients which they continuously obtain from the operating behavior of the overall unit and can compare them with preprogrammed values. All shifts are balanced out continuously. For the user this means e.g. that no aging occurs. Color values, image geometry, etc. remain intact once they have been set. In fact, one can expect a better picture as time goes on.

For the device manufacturer, the Digit 2000 system first of all yields a drastic reduction in the number of components in a television receiver. Added to this is automatic balancing during manufacturing, determination of operating convenience through software, capability for all television standards and for digitally

transmitted television programs. Furthermore, it offers possibilities which previously existed only in theory, for instance adaptive noise reduction and a flicker-free picture through intermediate storage. Digit 2000 is new top achievement of German engineering.

Valvo has taken another path: The digitally controlled television. This concept of distributive processing likewise collects together the control functions within a microcomputer (MAB 84XX) and distributes the real time signal processing to individual functional units, which the microcomputer controls through the I²C bus. Initially, it is not significant here whether the signal processing takes place in the function blocks in analog or in digital circuit technology.

In all discussions concerning digital technology, in television, one must not forget that even now the receivers contain a large number of digital functions. Convenient remote control, transmitter search, program storage would not be conceivable without microprocessor control and PLL tuning.

Passive components

Televisions, radios, industrial controls, computers, and all other electronic systems consist not only of diodes, transistors and ICs. Equally necessary are capacitors and resistors, relays and transformers, circuit boards, switches and keys, and finally housings and cabinets. With these products, too, one finds German manufacturers - both the "big ones", but also smaller special enterprises - among the leading vendors. Representative for many others, one might mention magnetic heads by Bogen, contact materials from Dürrwächter, motors and drives from Papst, microwave components from Spinner. Other papers in this issue will report concerning innovations involving relays, inductive components, capacitors, and resistors.

Stettner, in Lauf, founded a very special field of activity in 1922. Today it is a partnership company, independent of the conglomerate, with four production sites and 1000 employees in the Federal Republic. Stettner stands for technical ceramics and electronic components. Accordingly, a product palette is filled with various ceramics, fixed and variable capacitors, and HF components such as ceramic HF coils, and coil supports. One specialty is represented by the Slotfix components, which are suitable for automatic installation, and which are available as resistors, capacitors, disk trimmers, with good HF properties. Installation automats for simultaneous and so-called multiparallel installation of bulk goods are also delivered for these miniature components. In the area of chip components, Stettner offers a ceramic miniature chip coil with fixed values between 100 nH and 10 μ H and a quality of 50..25 for hybrid technology. In the program, one also finds acoustic converters and subassemblies for low frequency remote control systems, as well as commercial products of Asahi Company (resistors), Stackpole (resistors, switches, ferrites) and Murata-Erie (PTC resistors, ceramic-ZF-filters).

Tubes

Semiconductor technology has progressed steadily since the invention of the transistor and has limited the use of vacuum tubes to applications which cannot be solved or cannot yet be solved economically with semiconductor components: mainly picture recording and playback tubes, transmission tubes, microwave tubes, and a few less important marginal areas.

In the case of transmitter tubes, what is involved is the generation of large HF powers. While HF power transistors at best can operate up to a few hundred watts CW and a little over 1 kW in pulsed operation, tubes for transmitters and industrial generators can deliver many hundreds of kW and even up to 1 MW in CW operation. The Berlin tube works of Siemens manufactures such "big lumps". Big lumps for microwaves can be found in Valvo: Klystrons up to the megawatt class, such as are required for synchrotrons and other research installations. Even in the USA, only two or three others can keep pace.

In the case of microwaves, tubes also are still necessary in the lower power categories. Communication satellites and location finding systems work with output powers from 1 W up to about 100 W. Only travelling-wave tubes offer the required bandwidth and freedom from distortion and simultaneously high reliability. AEG can qualify against international competition for an entire series of projects. In the future, too, these will continue to be manufactured and further developed in Ulm.

While the transition to semiconductor centers is foreseeable with picture recorders - including TV studio quality - the presently usual monochromatic and color picture tubes will not be replaced by different playback systems in the foreseeable future. Even a flat picture tube for general use is not in sight. At this year's Hannover fair, a laboratory model of a flat picture tube was exhibited (elektronik industrie 5-1982, page 51). This made headlines for Siemens. But the company does not yet have a picture tube plant for mass production, if production readiness should be attained one day, and the company probably will have to find a suitable partner.

The last picture tube plant which was able to assert itself in Germany against the competition from the Far East is being operated by Valvo in Aachen. Here, 66 cm color picture tubes are being manufactured for the 30 AX system. Furthermore, Valvo offers a broad spectrum of monitor tubes. As display screen work stations become more popular, there is a rising demand for these tubes. As video display units, they are delivered with suitable deflectors, controls, etc. in all customary formats, for monochromatic and color displays.

The Supplier Industry - A World-Wide Estimate

The German component manufacturers can base themselves and rely on their own strong supplier industry. The total need for semifinished goods such as base plates for discrete semiconductor chip supports, caps, etc., as well as press masses, ceramic substrates, and even epi material or semiconductor crystals can be covered from domestic vendors. To this must also be added auxiliary materials such as technical gases, photoresists, chemicals, or e.g. liquid crystals. Top manufacturers in the research of these crystals include not only Hoffmann-La Roche in Basel, but E. Merck in Darmstadt, which world-wide is also the largest or second largest supplier. In 1981, about 16 million LCD displays were manufactured. Their foundations have already been known since 1888. Of the three possible crystal systems, the "rotary cell" is being used predominantly. Its light transparency is controlled electrically nearly without any power. Therein lies a great advantage of LCD displays, which work at a low operating voltage. New categories of liquid crystals are always being developed at Merck. The crystals used in rotary cells are mixtures of pure crystals, since only these have the desired properties (switching time, temperature range).

Ceramic substrates for hybrid circuits, support bodies for electrical resistors, and semiconductor housings of aluminum oxide constitute one area of the Rosenthal Technik AG in Selb/Oberfranken and Marktredwitz. Ceramic substrates for thin-layer hybrids (Al_2O_3 content 99.6 percent) and thick-layer hybrids ($\text{Al}_2\text{O}_3 \leq 96$ percent) offer good mechanical strength as well as maximum reliability in long term behavior, by comparison to other insulators. By using laser-scribed multiple substrates, one can manufacture several similar circuits in one working step. Through contacts to connect the substrate sides can be built with a laser beam. The growing need for housings for integrated circuits runs in parallel with the trend towards further miniaturization. A semiconductor housing can consist of several ceramic layers, the chip support, the circuit strip support, and an upper layer with a sealing ring, which are finally sintered together to form a block. After the chip has been mounted, the housing is closed with a cover. The housing of the future is the chip carrier, which makes do without conductor strips and which makes possible a large number of connector pins while maintaining small dimensions. The carrier materials for resistors, too, namely technical porcelain, alkaline earth porcelain, special stettite, and aluminum oxide ceramics, are constantly being developed further by Rosenthal in close collaboration with leading component manufacturers. They can now be manufactured with very close dimensional tolerances and with a defined surface quality, as mass products, in the form of rods, tubes with various geometrical cross-sections, borings, helices, grooves, and notches. Furthermore, Rosenthal delivers ceramic components for overvoltage leaders and piezo-ceramic components as firing elements or composite transformers.

Wacker Chemie, with its broad production program, is one of the largest suppliers of semiconductor materials altogether. Starting from highly purified silicon, polycrystalline, or as single crystals, zone-purified by drawing through the melt, through silicon wafers including epitaxy, up to polycrystalline silicon for terrestrial solar cells, the company has world-wide significance. GaAs is offered as single crystals drawn from the melt or boat-purified, or as wafers that are sawed and polished. For magnetic bubble memories, there is gadolinium-gallium-garnet (GGG) likewise as single crystals or in wafers. With this and with other auxiliary and supplementary materials for semiconductor technology, world-wide sales in 1981 amounted to 321 million DM, and employed 2280 employees.

Research for the Future

To stand still is to regress - an old wisdom, but it expresses that, in international competition, constant further development and the replacement of products no longer in demand by innovative products is necessary just to maintain sales and market fractions. To be equipped for the future, the large businesses maintain their own research laboratories, to create a scientific basis for new product development. Often they cooperate closely with colleges and universities, a practice that is increasingly also being followed by smaller firms, although naturally more product-oriented. Especially in microelectronics, the financial expenditures are constantly increasing because of the necessity of sophisticated research equipment. This increasing expenditure for basic research should be intercepted by increased cooperation between the interested firms. Such collaboration has been implemented in Germany, up to now, only in the Berlin Bessy project: Here, AEG Telefunken, Eurosil, Siemens, and Valvo formed the core of a development group which studied x-ray exposure for very fine IC structures.

Recently Siemens provided an insight into its research activities on VLSI circuits. Dr. Hans Friedrich, manager of the technical area of microelectronics at the Per-lacher research laboratory, explained that the "technological gap" relative to development, numerical simulation, production processes, circuit and system technology of VLSI circuits has now been closed. Projection exposure, ion etching and implantation permit structures down to 0.5 μm . Thus, MOS circuits with 100 ps delay times become possible. A ring oscillator with this value has already been implemented in the laboratory. Simple preprocessors for data arrays exceeding 1 Gbits/sec (in broad band communications, pattern recognition, speech processing) will thus become possible.

Fine geometries and high speeds are not everything, however: The rising complexity of the chips requires circuit techniques and architectures which yield regular structures and which thus facilitate computer-supported development. Finally, ICs with several tens or even hundreds of thousands of transistor functions require new test strategies for the qualification of a design and for its testing and production. The Siemens researchers anticipate integrating self-testing logic on complex chips which will work together with conventional tests.

Valvo, in a recent press conference, has also exhibited the work of its research laboratory. As already brought over into production, the laser diode CQL10 (elektronik industry 2-1981, page 30) was impressive with its wavelength of 70 nm. The switching circuits SAA7010 (EFM demodulation), SAA7020 (error correction), SAA7000 (residual error treatment), SAA7030 (digital filters) and TDA1540 (D/A converters) were likewise developed for the compact disk player. Only the explanations of the developers indicated the difficulties which had to be overcome to implement the technical data which had been possible in principle: dynamics, signal to noise ratio, channel separation exceeding 90 dB, and a nonlinear distortion factor less than 0.005 percent at 20...20,000 Hz.

For fast printers with high resolution, Valvo designed a light-switching device, which, using the electrophotographic process of commercial copiers, prints out an A4 page in 1.5 seconds. It is to be presented at the el ctronica. A monolithic color image sensor for video cameras will still require much research but this is also being worked on. Less spectacular are research efforts involving passive components. These often yield improvements only in small steps, but in the course of years this can accumulate to significant progress. Typical of this are the heightened operating temperatures and lifetimes of electrolytic capacitors, which have been achieved in recent years, and concerning which we report on page 46. Sometimes, however, information can be transferred from other areas or new technological paths can be opened up which yield really discontinuous improvements of technical properties.

Business Climate: Better Prospects for the Future

The electronics business climate has revived somewhat this year as compared to 1981. At that time, according to the data of the ZVDI (Central Association of the Electrical Engineering Industry), sales increased nominally by only 4.2 percent, which corresponded to a real increase of 0.8 percent. Production regressed by 1.5 percent. For components, one even recorded a decline of 12 percent for passive components and 3.6 percent for active components. The only area with noticeable growth in 1981 was the EDP branch.

The decline is and was primarily based on the poor business climate domestically, while foreign demand grew strongly and prevented a still further business recession. The electronics industry in 1981 had an export excess of 14.2 billion DM, and contributed decisively to relieving the German balance of payments. According to a situation report by Fritz-A. Lohmann, business manager of Valvo, microelectronics, an indicator for the technical standard of the national economy, lags in the Federal Republic of Germany with 23 DM per year, as compared to Japan (44 DM) and the USA (42 DM). Within Europe, including the Federal Republic, the consumption is 12 DM, and here we occupy a relatively leading position. But a comparison with Japan and the USA shows that microelectronics is not being used sufficiently by us. In this year, according to information from the ZVEI, the signs that business development had hit bottom began to increase during the first quarter, despite the retrograde domestic business. The strong increase in the number of units for components, which had been expected for the second half year of 82, did not materialize, however, as was also the case for the generally hoped for business upswing. Expressed in numbers, the component industry looks as follows: production for the first quarter of 82, 1170.9 million DM (+ 4.0 percent as compared to 1981), second quarter 82, 1195.5 million DM (+7.0 percent), export, first quarter 82, 1076.1 million DM (+10.6 percent), second quarter, 82, 1090.9 million DM (+18.8 percent). Comparable values are expected for the third quarter, and things may improve in 1983.

In the economic considerations, one must not forget that e.g. in 1981 components valued at 4633.5 million DM were imported, that is more than were produced (4429.1 million DM). This means that there is an additional demand for components which either are not offered on the domestic market or are not available in the required numbers of units.

On the following pages, we will report on the newest and current component development and applications, as examples of the activities of German component and semiconductor manufacturers. In view of the offer of active and passive components from the USA (elektronik industrie 8-82) and Japan (elektronik industrie 1-82) and the lagging know-how as well as the price pressure associated therewith, the battle signs are also apparent for the future. The German semiconductor industry, apart from a few special disciplines, is not capable by itself of counteracting the pressures from the countries of unlimited opportunity and of the rising sun. The program to promote microelectronics is an experiment, these national measures - and they also exist in France and Great Britain - harbor the danger, however, that work is done on one problem along several tracks. The European countries with their collective high potential in microelectronics should decide for giant development activities such as e.g. with nuclear research. Only in this way can they face the Americans and the Japanese.

Fritz A. Lohman sees still further difficulties. For example, German and European legal standards, which prevent economically meaningful corporate collaboration, which would be necessary to produce economically an optimal production quantity. Also, the social legislation plays a role, when the point is to make more efficient, displace, or close uneconomic operating units.

Since the joint European activities which have been addressed above, if they come to be at all, will require a certain time, our salesmen in the meantime should try to do business with significant markets, using already available and technologically mature products. Certainly, we are far e.g. from the US market, but is this not also true for the Japanese?

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ELECTRONICS

EUROPEAN SEMICONDUCTOR INDUSTRY: MARKETS, GOVERNMENT PROGRAMS

Essen ELEKTRONIK-APPLIKATION in German Sep 82 ELEKTRONIK-INTERNATIONAL
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/Article by Achim Scharf, Editor of Elektronik Applikation, Munich/

/Text/ The semiconductor industry in Europe and especially microelectronics is today situated between the millstones of USA and Japan. The concerned enterprises and governments appear to lack the motivation for close cooperation using European resources, which would correspond to the ideas of the contracts on which the common market is based. Consequently, microelectronics is being promoted in individual countries under more national perspectives, and the enterprises are pursuing strictly their own interests in cooperating with predominantly American and Japanese partners. This report provides an insight into the European semiconductor scene, its markets, as well as assistance for promotion and establishment available in the individual countries.

From a worldwide perspective, the USA dominated until the middle of the seventies, for example, in the mass production of 16-K DRAMs. In the meantime, with the next generation, the 64-K DRAMs, the Japanese have outstripped the US companies. These chips are now an evaluation criterion for the innovative power of a semiconductor enterprise. Precisely in memory modules with their typical regular structure, technological preliminary work for subsequent more highly integrated circuits with more complex functional characteristics, such as microprocessors and their supporting modules, can be guaranteed. Besides these technological aspects, the memory market also has a very strong commercial note, however, since the 64-K market is supposed to reach a volume of 1 billion dollars in the late eighties. According to VWD (Associated Economic Services) data, Japanese companies like Hitachi, NEC, and Fujitsu currently supply about 70 percent of the world market demand for 64-K RAMs. Advance work on 256-K DRAMs has been announced and 1-M chips are on the horizon.

Up to now, the Americans have been more innovative in the conception of new microcomputer architectures and system families. The Japanese have been increasingly more conspicuous in the role of converting such architectures into progressive CMOS technologies, and as mass producers of memory chips. The world demand of such products, however, will rise more steeply than the demand for microprocessors (Figure 1). In this game, the European companies take over the part of a second

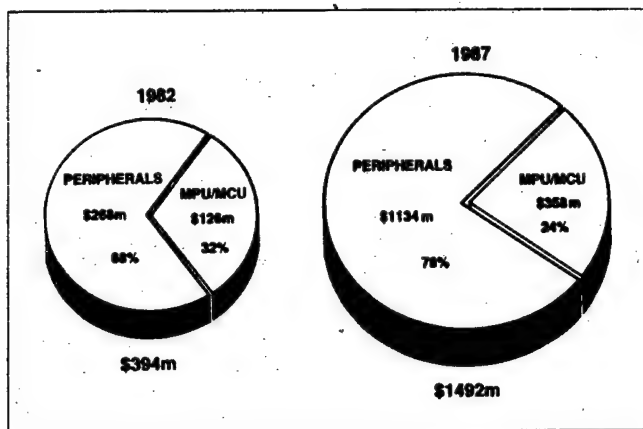


Figure 1:
The World Market for 16/32-bit Microcomputers Will Grow Enormously During the Next 5 Years. However a still higher demand for peripheral circuitry and memories is expected (Source: Motorola)

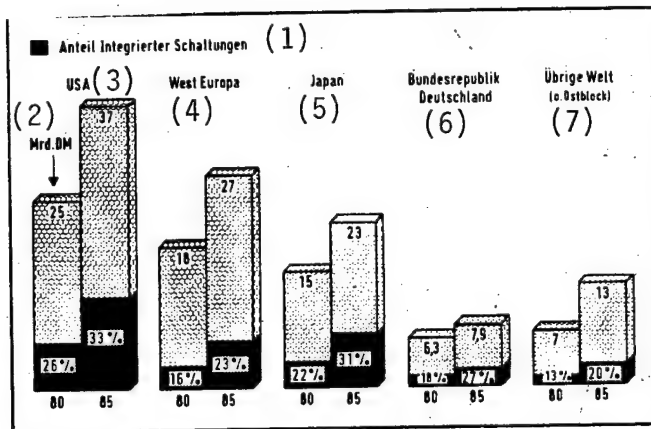


Figure 2:
Expected Development of Components Production (Source: Valvo)
Key:
1. Portion of integrated circuits
2. Billions DM
3. USA
4. Western Europe
5. Japan
6. Federal Republic of Germany
7. Remainder of the world (excluding the Eastern block)

source for popular or derivative microprocessor families and the definition of support components, although companies like Siemens or INMOS can also deliver 64-K DRAMs in numbers of units according to their own specification. The marketing success depends on price and quality, and here it will appear whether Europeans are or will become a serious factor in this business.

In the USA, in any case, according to the wish of the affected enterprises and in agreement with the US Administration the "Japanese challenge" is to be countered with protectionistic and cooperative means. As a first countermeasure, the US electronic enterprises demand an import restriction on 64-K chips. Here, the Reagan Administration is investigating a limitation "for reasons of national security". A second initiative should lead to the foundation of a joint research association, the Microelectronics and Computer Technology Enterprises. This is supposed to promote joint basic research in semiconductors and thus should minimize duplicate work in the participating companies like Control Data, DEC,

TI, Motorola, AMD, Mostek, NS, Xerox, Sperry, and Borroughs. This complex evidently is supposed to respond equivalently to a similar but government-coordinated Japanese association principle. Initial negotiations occurred in the spring of this year, with the approval of the US Government. A Semiconductor Research Cooperative is supposed to coordinate semiconductor research at American University, and is supposed to provide additional impulse.

In view of falling total sales of the American and European semiconductor companies by 8 percent in 1981, and in view of the rise of the Japanese IC production by 29 percent per year during the time period from 1976 to 1981, as well as a further annual increase by 12 percent until 1986 - in 1981, IC production amounted to about 3 billion dollars - the US semiconductor companies are afraid of losing control of their domestic market. In 1980, US suppliers still controlled 66 percent of their domestic market. According to projections, this portion can shrink to 50 percent by 1985. With the 64-K chips, it may reach only 20 to 30 percent of the total volume.

According to a Mackintosh study, the 20 leading manufacturers in Japan's semiconductor industry invested about 1 billion dollars during the preceding year in new production equipment. Their declared objective was to increase further the mass production of VLSI components. Because of this fact, one expects a similar order of magnitude for this year also. Accordingly, the production volume of ICs should rise to about 5.2 billion dollars by 1986. One figure for illustration: According to the data of Hitachi, the production figure of 64-K DRAMs is now more than 700,000 per month.

In view of the recession in the USA and in Europe, which causes sales losses and primarily profit losses for most of the large semiconductor manufacturers, the objections against the unpleasant competition from Japan are becoming stronger and are directed against the specific research subsidies from Tokyo, against the market division between individual Japanese manufacturers under the collaboration of the Export and Industrial Ministry MITI as well as against the fact that the inland Japanese market is de facto closed against outside suppliers.

Figure 2 shows the expected development of components production. According to this projection, the world production of components in 1985 will reach a value of 100 billion DM. The portion of ICs will double to 28 billion DM during the period from 1980 to 1985. However, there are considerable differences here between the figures presented by Mackintosh and by Valvo, but the trends become quite apparent. If one uses Figure 2 as a basis, it appears that Western Europe will continue to decline in IC production as compared to Japan.

After these more world-scale considerations, the Western European semiconductor industry will be illuminated below in somewhat more detail, by way of regional specifics.

GERMANY

By the end of the year, the Federal Ministry for Research and Technology will have invested about 600 million DM (since 1976) in funding research for electronic components. About 70 percent of these funds were credited and continue to be credited to industrial research, the remainder to projects in colleges or at the Fraunhofer Society. With 25 to 30 percent, Siemens is at the top, before AEG Telefunken with 10 to 15 percent, Valvo with 10 percent, as well as Eurosil and recently also Intermetall. At Intermetall, the signal processor project is being funded. Through a new funding emphasis for working out the technological preconditions for structures in the $1\mu\text{m}$ range, which probably will take up a considerable portion of the total expenditures of the BMFT during the next 4 years, the accents have shifted somewhat within the funding program.

In 1981, the market for components in the Federal Republic declined by 9 percent as compared to 1980, while the production of the German component industry was reduced by 6 percent (1980: 4.38 billion DM). Exports rose by 2.4 percent, to 3.83 billion DM, while imports increased to 4.63 billion DM (+3.6 percent). Without exception, all component categories recorded a decline, except for ICs, which experienced a production increase of 8.6 percent. Considering the fact that the IC market in Germany declined by 14 percent, a strong increase of the market fraction of German companies or companies manufacturing in Germany is becoming clear in this area. Altogether, the ZVEI (Central Association of Electrical Engineering Industries) is forecasting a growth of 5 percent for the components industry in 1982. Here, the decisive factor is supposed to be IC production with a growth rate of at least 10 percent.

The use of microelectronics is being promoted in Germany during the period from 1982 to 1984 within the framework of a special program. This program is particularly supposed to address medium businesses by rapid and non-bureaucratic processing of applications. Up to now, 300 million DM have been allocated for this program. However, since 1800 funding applications were already submitted by the middle of 1982, the Minister for Research and Technology, Andreas von Bülow, requested a funding increase to a total of 450 million DM. According to the Minister's opinion, the use of microelectronics will be decisively promoted by these stimuli, a necessity if jobs are to be secured and new ones are to be created. Furthermore, the Minister is satisfied concerning the quality of projects that have been submitted for funding since January of this year. This program is running under the project management of the VDI (Association of German Engineers) Technology Center in Berlin. Using funds from the BMFT (Federal Ministry for Research and Technology) this organization provides technological consultation not only in the area of electronics but also in physical engineering, and specifically also for medium businesses.

Siemens

For the current business year, Siemens is looking for silver linings on the horizon even in the business area of components. After 8 months of the current business year 1981/82, the sales and order backlog are at the level of the previous year and Siemens is supposedly able to compete in the world market,

according to statements by the Chairman of the Board of Siemens AG, Karlheinz Kaske. However, this business area is said to be not yet profitable. Only in the following year does Siemens expect to be in the black here. According to the data from the 1980/81 Annual Report, the proportion of component sales was 5 percent of the total sales. During the year under report, 1.6 billion DM were sold, and with the addition of internal deliveries, the component sales amounted to 2.2 billion DM. The portion of microelectronics reached 400 to 500 million DM. This sector also seems "essential" to Kaske.

After concluding cooperation contracts with Intel, Siemens entered the microcomputer business in 1976. After 4 years of engagement, more than 100 million DM sales were achieved, and growth rates between 30 and 50 percent continued to be expected. The entry into the market first began with the marketing of products of the cooperation partner; later, selected second-source products were taken over into Siemens own production. Finally, Siemens independently defines, develops, and produces, within the framework of product lines supported by both enterprises. Previously, this included, among others, the 8080/8085; in 1979, a second-source contract was concluded concerning the 8086; first samples from Siemens in-house production were available in the spring of 1981, and shortly later larger numbers of units were available with 4 and 5 MHz cycle frequency. According to statements by Dr. Eng. B. Huber, Marketing Manager for Microcomputers at Siemens, the 8086 CPU is being produced on the scale of several 10,000 per month; selected versions are also being produced with 12 MHz cycle frequency (2 μ m structures). Good yields are obtained with the 10 MHz version; expanded application areas to ambient temperatures up to 125°C supposedly can be covered with the Siemens 8086. The 8087, a numeric coprocessor for calculationally intensive applications, is not being produced by Siemens. However, the system modules of the SAB 8282 through 8288 are included in the program. The microcomputer business at Siemens is supported by its own technological base. Since 1974, the enterprise has started up five MOS production systems, including a production center for highly integrated MOS circuits in Munich in 1980. Circuits with 150,000 transistor functions per chip (2 μ m) can here be first implemented.

During the past year, Intel/Siemens looked back on 5 years of cooperation during which Siemens developed from "receiver to partner", according to its own estimation. What will be desirable is a role change from "receiver to giver" (editorial note). For this reason, a new phase of collaboration was announced, an agreement concerning the 80286 processor. The 80280 chip comprises 130,000 transistor functions, compared to 29,500 with the 8086. With an 8 MHz cycle frequency, programs of the 8086 can run in six-fold processing speed in the "real-address-mode" of the 80286. At Intel, mass production is supposed to start at the beginning of 1983, and at Siemens by the end of 1983. For this family, Siemens is designing a DOT-rate generator, a bipolar component, which is especially suited for test-processing tasks. Siemens is thus underscoring the specific use of this processor in the "office of the future". Furthermore, Siemens is developing an "advanced DMA controller" with a data throughput of more than 8 M bytes per second, a new achievement, in the opinion of B. Huber. Intel has recently presented the 80186, as well as the 32-bit microprocessor IAPX432, neither one of which is currently relevant for Siemens.

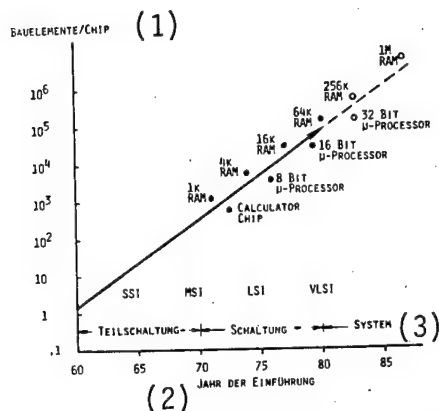


Figure 4:
Forecast Time Sequence of the
Availability of Highly Integrated
Microprocessors and Memories
(Source: Siemens)

Key:
1. Components per chip
2. Year of Introduction
3. Component circuit, circuit,
system

On the single-chip microcomputer sector, the 4-K version 8051 has been mass-produced since the spring of 1982. The 8048/8021 is being produced in AMD cooperation. The 8049/8050 is not being produced, but application-oriented computers are to fill this context. According to Huber, more than 1 million units of the type 802010 were sold during recent months.

64-K RAMs, an evaluation criterion for innovative power, are being mass-produced in their ceramic version, and a plastic version is starting up. In 1983, 256-K RAMs are to be demonstrated, but according to the view of Siemens, the market will not develop before 1985. Siemens believes itself to be technologically equivalent with US companies in this sector, but an advantage is generally conceded to the Japanese. According to Huber, the market for 256-K/64-K will have balanced out bitwise by 1983, and will be equal unit-wise by the end of 1984 (Figure 4). There are no plans on the EEPROM sector.

In cooperation with AMD, Siemens is developing a CMOS process (3.5 μm channel length), which can also be adapted to single-chip microcomputers. Three LSI-CMOS units will shortly be available.

The future of the German component industry, according to Huber, lies in digital technology, where the slogans are the office of the future, CAD/CAM, or opportunities for efficiency generally.

AEG Telefunken

At AEG Telefunken, single semiconductors and ICs are being manufactured with a production value of more than 200 million DM annually. The production value of integrated circuits is more than 100 million DM, with an average yearly growth rate of more than 10 percent. In the MOS sector, only custom-specific circuits are being produced; there are not standard circuits in the program.

AEG Telefunken has expended more than 200 million DM for material and personnel investments within the framework of LSI production. Structural widths of 3 μm can now be mastered in production.

At this time there is no active cooperation as there once was with Rockwell. However, the intended foundation of an AEG Telefunken/Mostek production for ICs was recently applied for at the Federal Cartel Office. Both businesses should each have a 49 percent interest in this joint venture, and a large bank 2 percent. Funds in the amount of 20 million DM were announced by the BMFT for this project. At the Heilbronn Semiconductor Plant of the enterprise, about 2,000 employees are being occupied. With IR detectors for night vision devices, that is for military applications, AEG Telefunken has created another branch from which the enterprise hopes to reap a return of about 25 percent of the production value of the semiconductors from Heilbronn. The know-how required for this was acquired by purchasing licenses from Texas Instruments, which also planned and delivered the production systems. The production building, a 100 million DM project, was handed over to its intended purpose in October 1980.

In October 1981, AEG Telefunken approached the public with a new activity under the slogan, "You don't need to go to Silicon Valley"; its new development center for integrated circuits in Ulm. This activity is intended primarily to offer design support to system and device developers, but also to product developers, so as to achieve optimal systems with ICs, independent of the production volume, according to statements by J. Dangel, Manager of the Development Center, at the occasion of a presentation before the technical press.

The services of a Development Center are not limited only to the conglomerate, but are also offered on the free market, so that even small and medium businesses can have access to IC development and testing, without requiring the corresponding high internal investments in know-how and machinery.

Circuits according to customer specifications are being developed primarily. For this, one does preliminary development as well as checking for integrability and computer simulation of a designed IC. A VAX-11/780 with 10 terminals is available for this. The layout is worked out by means of an Applicon system comprising four connected display screen work stations. By coupling the VAX and the Applicon, very calculationally intensive jobs can be executed. Masks are generated on a 1:1 scale in the Heilbronn Semiconductor Plant, on the E-beam. The wafers are produced in the standard technologies bipolar, I²L, PMOS, and NMOS (3 μ m) likewise at the Semiconductor Plant. For other technologies, such as CMOS, one draws upon outside semiconductor manufacturers.

The 100 percent testing of the fabricated ICs is again possible in the Development Center. For this purpose, a Sentry VII is available for digital tests, and a series of IEC bus controlled measuring stations is available for analog tests. The combination of this test equipment facilitates mixed analogs - digital tests.

Semi-customized circuits can also be worked out with the means of the Development Center. Figure 5 sketches the customer-vendor relation of the Development Center. For the industrial branches which as yet have no electronics experience, close collaboration with the VDI Technology Center has been agreed upon, which advises and assists these companies in the advanced field of integration, when they convert from mechanics to electronics.

Valvo

Fritz A. Lohmann, a member of Valvo's top management since February 1982, entrusted with the business area of components from the Philips GmbH, expects a gradual rise of the component demand, as compared to the previous year, a trend which will continue and increase in 1983. According to its own estimate, Valvo already has the broadest product palette in Germany. By means of this, and by means of its Hamburg IC production, which is expanding rapidly, Valvo intends to acquire further market fractions.

According to a Dataquest Study, Philips, including Signetics, with estimated world sales of more than 950 million dollars, occupies third place (1980) after Texas Instruments and Motorola. ICs accounted for about 640 million dollars. In Germany, Valvo considers itself as the second largest IC vendor, after TI.

With Valvo, VLSI means production on one lane, which offers the possibility of implementing structures up to 2 μm . For the overall enterprise, this implies innovation investments of the order of the sales growth. VLSI products presuppose system know-how, according to Lohmann, and thus VLSI products will be directly reflected in projects involved with digitalization in the audio and video sector. This statement holds especially for ICs in the growth areas of VCR and TV. There is a particularly strong position especially with analog ICs. At the same time, more and more functions are being digitalized; here, tuning units for VCI and TV as well as circuits for video and CRT text occupy the first place. Thus Valvo delivers microprocessors from its Hamburg production for such applications. For the radio area, too, new concepts are being presented for signal processing and for tuning.

Bipolar technologies are being developed further in important variants, among these ECL and ISL, including their applications to gate arrays. In the MOS sector, one is using the NMOS technology in an HMOS process. CMOS here also occupies a central position. This technology is important for gate arrays, logic circuits, microcomputers, and in the future also for analog circuits. In March 1981, Philips decided to enter a long-term cooperation with Motorola concerning the 16/32-bit microprocessor family 68000. At this time, in the view of Lohmann, the 68000 was the most powerful system, and the second-source situation also offered the greatest opportunities to make this family into a world standard. With this processor family, whose 32-bit upwards compatibility did not very strongly influence the favorable decision, one would like to approach a broad market which extends from motor vehicle technology to telecommunications and measurement, control, and regulation technology, right into electronic data processing. Between Motorola and Valvo, a certain subdivision of the development work was agreed upon. Thus, Motorola will develop especially CPUs and system components, while Valvo will be primarily concerned with application-oriented peripheral circuits up to custom-specific switching circuits. On the operating system side, a decision was made in favor of Unix. Development support is being offered with the PMDS(II) of Philips. Valvo considers the market of 8-bit single-chip microcomputers especially important. Thus, the 8021 and the 8048 are being produced in massive numbers of units. The 8048 is

based on a cooperation contract with Intel. The 8400 (8500) is an in-house development, an expanded 8021 architecture with up to 4-K bytes ROM and a serial interface on the chip, which permits a multimaster configuration. CMOS versions of the 8048 and 8400 have been available recently.

Hamburg is the technology center for Philips. Here, the equipment necessary for qualified development and production is available.

Lohmann also sets his hopes on the fast CMOS CMOS logic family, which emerged from cooperation with RCA. In his view, this may surpass even the Philips LOCOS family in market significance.

Intermetall

Intermetall is the largest exporter of semiconductor components in Germany and also the smallest importer, according to a statement by Lubo Micic on company policy. L. Micic has been Managing Director of ITT Semiconductor Worldwide for about 3 years, and is active as Business Manager of Intermetall.

Manufacture takes place in Germany; only 10 percent of sales are imported, predominantly memory chips from England. Import from the USA is scarcely significant, and there is not import at all from the Far East.

According to Intermetall's own data, the business volume at the end of 1980 was 250 million DM. Exports were about 145 million DM, and imports about 25 million DM.

According to data from Dataquest, ITT in 1980 attained total semiconductor sales of 250 million dollars. 146 million were quoted for ICs, although with a growth rate of 72 percent as compared to 1979.

All processing and finishing steps are performed in Freiburg or in European production sites. About 50 percent of the products go into entertainment electronics, 15 to 20 percent into telecommunications, 10 to 15 percent into industrial electronics, and 10 percent into motor vehicle electronics.

In the telecommunications area and in the area of digital signal processing, Intermetall is very strong, not least of all because of its cross-connection with SEL. Codec components are also produced and are sold within the framework of telephone activities. About 65 percent of the sales are activated with application-specific switching circuits. Microcomputer activities extend from 4 to 16 bits.

A single-chip computer with 4-bit word width in CMOS technology is available for consumer applications. As a secondary source for the 9900 family of TI, Intermetall wants to produce the entire series from peripheral equipment up to the CPU.

Newer technologies at Intermetall are CMOS with 4- μ m structures (Si gate) and 3- μ m NMOS. Structures of 2 μ m should be achievable in 1983 by means of optical lithography methods. For quality that meets production requirements, wafer steppers will be used, however.

An E-beam is used to produce masks. Copies can be made from these chrome masters, which are used in production in connection with 4-inch wafers. For study purposes, 1- μ m structures can thus also be written directly on the wafer.

Intermetall predominantly makes switching circuits with random logic where the technology must fulfill different conditions, in contrast to memories. Non-volatile fast memories are also being developed in combination with random logic.

The layout of an IC is designed according to symbolics. As a result, about 15 percent of the chip surface is lost, but one obtains chips for production. For certain applications, basis cells are also used. A closed center was erected in-house for layout work. As Micic emphasizes, Intermetall's goal is not technology per se, but technology is supposed to be the means for making sales, and this is very successful.

Eurosil

Eurosil was founded in 1971 as a subsidiary of Intersil. From the beginning, it has specialized in CMOS switching circuits.

In 1975, Diehl acquired the majority of the shares (68 percent). Other shares are held by the Société Suisse pour l'Industrie Horlogère S.A. (23 percent) as well as the Banque de Paris (5 percent).

According to data from the Diehl Chairman of the Board, Dr. Stehle, the sales of components of the Eurosil subsidiary could be doubled from 30 million to 60 million DM. Milestones of company development were the presentation of the first CMOS microprocessor with 1.5 V supply voltage for wristwatches in 1977, the diversification with CMOS gate arrays in 1980, the licensing of Mitel Corp. for telecommunication switching circuits in 1981, and the start-up of a new semiconductor factory in Echting near Munich in 1982. An area of about 7,000 m² is available here for development of production, and 560 m² are reserved for administration.

The production capacity is about 15 million switching circuits per month. About 280 employees are occupied.

Important product groups are large and small watches with digital and analog displays, stopwatches for industrial applications, customer-specific ICs, mask-programmable microcomputers, telephone switching circuits, and motor vehicle electronics. These components are being fabricated in metal gate, silicon gate, high voltage, ISO, and ISO² CMOS.

Fairchild

In 1981, the first ground was broken for the German semiconductor production site of Fairchild in Wasserburg am Inn. The first building section was finished for its intended purpose in May. About 250 employees will here be occupied in the nearest future.

The site location near Munich was not accidental but was based on careful analyses on the European plane. Several factors which influenced the choice of site were the following: the labor force potential in the sector of engineering and production experience in this region, the effect on key customers, and the potential market, as well as support from local agencies. Upon conclusion of the second building section in April 1984, a fully automated production site will be completed in addition to the present test and assembly line. This will begin with the preparation of silicon and will deliver finished products to the European and US market. The production line will work with 4-inch wafers and will produce bipolar LSI switching circuits, gate arrays, as well as the component families ECL 100 K and FAST.

Other Activities

Besides the administrative activities, manufacturers like Texas Instruments (Freising), Motorola (Unterföhring), and Hitachi (Landshut) have also opened up production activities for servicing the inland market.

A new path for customers with a small to medium IC demand is offered by Prema in Mainz with its so-called application-oriented IC development. In this case, the customer must perform the circuit design under his own supervision, and must provide Prema with the mask tape, where the desired circuit is then fabricated specifically for the customer and at comparable costs like a gate array.

The basis for this design is an interactive design system ICE-1, which is loaned out for a certain period of time at a fixed price. A component of the design system is a basis cell library, which makes it possible to implement LSI components up to 7,000 gates per chip or mixed digital/analog functions.

Bipolar, TTL, ECL, and I^2L technologies are available.

FRANCE

In 1981, the French electronics industry achieved total sales of equivalently 4.9 billion DM, and still a growth of 7 percent. In 1980, the growth was 18 percent. Active components had a portion of 2.1 billion DM (+8 percent) in this result, where the growth of ICs, with 18 percent, was particularly high.

Now as before, Germany is the best customer of the French component industry (790 million DM, +11 percent). But the Federal Republic is also the number one supplier for France (770 million DM, +30 percent).

Since 1977, the French government is promoting the build-up of an independent semiconductor industry. Within the framework of this first 5-year plan, 600 million FF (295 million DM) were distributed among five businesses, and specifically EF-CIS, Eurotechnique, Matra-Harris, RIC, and Thompson-CSF. Only those companies were funded where French companies had a majority. Among these do not belong the production sites of TI at Nizza and of Motorola in Toulouse. Besides TI and Zilog, nearly all large semiconductor companies have at least indirect participation in the funding, because Harris and National Semiconductor

respectively control 49 percent of Matra-Harris and National Semiconductor Company, and Motorola has a second-source contract with EFCIS. In 1981, Intel concluded a cooperation contract with Matra-Harris.

The second 5-year plan, which is starting this year, will strengthen France in its export trade in the area of microelectronics, to such an extent that the 1981 deficit of equivalently 240 DM can be balanced out before 1986. The goal of this plan is to support internal research projects and to promote the use of ICs in business. Already for 1982, the state is making available 160 million DM for research and development on ICs. These funds will be distributed by five ministries. The electronics industry will continue to receive low-interest credit in the amount of 135 million DM. Assistance for further years has not yet been exactly specified. By 1987, however one expects a financing need for industrial microelectronics equipment amounting to 875 million DM, and research expenditures at 1.35 billion DM. So that these means can be applied more effectively, the Industrial Ministry is pressing for a closer collaboration between the competing enterprises.

EFCIS

65 percent of the EFCIS shares are held by Thomson-CSF, which again belongs to Thomson-Brandt, but this conglomerate has recently been nationalized. Thomson-CSF again is a mixed enterprise active in the sectors of information technology, medical technology, and components. EFCIS belongs to the components area.

Today EFCIS is employing 2100 people in two plants. The production area is given as 50,000 m², the production volume for 1982 is said to be 730 million FF. These figures comprise the production of bipolar, MOS, and newly initiated logic array components, as well as systems. Since a bipolar linear gate array has already been available for years, two lines of CMOS gate arrays with an Al- and Si-gate have been developed. In the area of ECL gate arrays, EFCIS is looking for a suitable cooperation partner, but in the USA, and it is believed that he has already been found.

A brief history: In 1978, the HMOS-I technology was taken over from Motorola within the framework of the licensing agreement. In a further agreement, EFCIS became the second source for the 6800. In 1979, a second-source agreement was signed concerning the 68,000, and in 1981 it was decided to take over the CMOS version of the 6805. In this year, by putting together the MOS activities (EFCIS) and the bipolar activities (previously Sescosem), Thomson-EFCIS was founded. In the internal combination of interests, the government influence exceeds 50 percent. In 1981, Videosil Company was also founded, which is active in the area of semiconductor sensors and which is to become productive by 1984, as well as the centralized production of customer-circuits including gate arrays.

In 1982, Thomson-EFCIS concluded an agreement with AMD concerning technology exchange. AMD accordingly will receive know-how concerning the video processor EF 9340 and the associated character generator EF 9341, while Thomson-EFCIS will produce the bit-slice processor 2901 C as secondary source beginning in 1983. Furthermore, the bipolar 16-bit multiplexer 29516 is included in this agreement.

Thomson-EFCIS has high expectations from these lines; the cooperation with AMD is to be deepened in the future.

A mask exchange of the 68HC04 against the 6805 CT is to be made with Motorola. This component was conceived by Thomson-EFCIS specific to the application (telephone applications).

Other focal points, according to the Marketing Manager Andre Raudin, are the following:

Beginning in 1983, HMOS II (1.2 up to 2 μ m) will be used for the 68000 and other in-house developments. Components with 20 MHz cycle rate (mid 1983 of the 68000) will be offered therewith. Beginning in September 1982, models of the 68000 with 8 to 12 MHz will be available. The 6809 is currently being brought into production. 10,000 chips per month are envisioned in the immediate future. Of the 6800 family, Thomson-EFCIS is producing more than 1 million chips per month. The market introduction of the 6804 (1 K ROM, 32 byte RAM) should take place in the beginning of 1983, 8 bits for the 4-bit price, as Raudin indicates.

An EF 68071 with one-chip EPROM is under discussion.

The essential bipolar activities are in the sectors of entertainment electronics and power electronics, and here especially concerning ICs for controlling power transistors, as a supplier for Thomson-CSF.

Matra Harris

In January of 1980, the first wafer was produced by Matra Harris in Nantes. Since that time, more than 2 million switching circuits have been produced. The monthly output currently is 2,000 wafers per week.

At the end of 1981, MHS engaged 300 employees, of these 100 engineers. Since 1982, work has continued in three shifts around the clock. The personnel plan envisions about 1600 jobs by 1986.

In 1981, the production value was 29 million FF. By the end of 1983, this value is to increase ten-fold, and in the following 3 years it is to be doubled each year.

Beginning in 1983, Matra Harris Semiconducteurs, in its own estimation, is one of the few manufacturers to produce a complete line of 4-bit, 8-bit, and 16-bit microcontrollers and microprocessors in CMOS technology. Through its cooperation with Intel, 8-bit and 16-bit components in NMOS will already be available in 1982. Furthermore, MHS is active in the area of CMOS gate arrays. The production of bipolar switching circuits should start in a new building by mid 1983, and finally, in 1984, assembly and test will follow in another new complex. Finally, MHS in Nantes is producing, with the HM 65161, a static CMOS-RAM (15 K) with an address access time of max. 55 ns.

As regards the nationalization plans, Matra President Jean-Luc Lagardere is pessimistic concerning the continuance of cooperation with US companies, who have confirmed that cooperation would terminate in the case of complete takeover of Matras by the state.

Eurotechnique

In April 1979, Saint-Gobain-a-Mousson and National Semiconductor concluded a joint-venture agreement to set up a semiconductor factory in France. This resulted in the company Eurotechnique, whose shares are distributed among the two enterprises in the ratio of 51 percent and 49 percent. By 1984, 400 million FF are to be invested in MOS production. NS will here mainly supply know-how, licenses, and personnel training.

As far as technologies are concerned, NMOS (XMOS) and since this year CMOS (P²MOS) have been available, by means of which not only EPROMs and dynamical as well as static RAMs are produced, but also microcontrollers (COPs), microcomputers (8048, 80C48) as well as microprocessors (NSC 800, NS 16000). Besides these standard circuits, Telecom ICs will also be offered in CMOS.

The plant is situated in Rousset-sur-Arc near Aix-en-Provence. By 1984, 800 employees will be occupied there, and the gross business should amount to more than 1 billion dollars. The production capacity is about 50,000 4-inch wafers per month. The production installations, however, have already been prepared for 5-inch wafers.

Besides pure chip production, Eurotechnique is also dedicating itself to the manufacture of 8-bit card systems in the Europa format. This card family consists of 15 modules and will be available in piece numbers beginning September 1982.

Thomson-CSF

The component group of the Thomson-CSF is resident in a 20-year-old plant (18,000 m²) in Aix-en-Provence. About 1,000 employees are engaged here, and another 800 in Tours. The production value of the Aix plant is about 9 million DM per month and primarily concerns discrete components. Focal points of the production program are power transistors, predominantly bipolar ones, as well as diodes.

Some monthly run-through figures:

10 million minisignal diodes, 20 million zener diodes (0.5 W), 5 million zener diodes (1 W), 2 million power transistors, and 600,000 rectifiers.

At this time, 3-inch wafers are being processed in maximally 55 diffusion tubes. According to the wish of Bernard Girou, Director of the plant in Aix, production is to be increased by the integration of diffusion cycles for diodes, Z-diodes, and transistors. More than 80 diffusion tubes and 4-inch wafers should increase the usable chip surface by a factor of 1.8, and should contribute towards fulfilling the rather exaggerated sales expectations.

Reasons for a 150 percent production increase in 1982 as compared to 1981, according to Girou, are the following: The market for fast rectifiers is expanding strongly, as is also the market for zener diodes. Furthermore, the previous Europe orientation is to be loosened and the markets in the Far East and the USA are to be increasingly serviced. Further activities in Schottky diodes and SOT-23 components serve this purpose.

To make the specifications in the data sheets clearer to the developers, Thomson-CSF will soon specify the parameter U_{CEW} for power transistors, i.e. the collector-emitter working voltage at maximum collector current (W stands for worst case). As a reference for the reliability of the power transistors fabricated in Aix, Klaus Rischmüller, Manager of the Application Laboratory, cites a parallel circuit of 250 BUX 48 II for power transistors of 1 MVA at the particle accelerator in Grenoble.

As regards the nationalization of certain portions of French industry and of the banks, Girou is of the following opinion: This makes available to the enterprises a central control for the more effective utilization of resources. The nationalized companies should represent the locomotives which are financed by the nationalized banks. Individual profit should be recoined into general profit.

GREAT BRITAIN

An assistance program in the amount of 55 million pounds, to fabricate micro-electronic components, terminated in 1980. A similar amount has been made available from 1978 to 1983 for the application of microelectronics. Furthermore, the British Treasury has announced an assistance package for new technologies in the amount of 130 million pounds. By 1985, 100 million pounds of this is to go into software, information technology, the application of micro-processors, as well as into optoelectronics and the use of numerically controlled robots. The remainder is available to support broader applications of the view-data system.

All these systems directly concerns the use of semiconductors. In 1980, a production value of 241 million pounds is specified for semiconductors, for companies resident in England. This statistic evaluates the market at 313 million pounds, export at 211 million pounds, and import at 283 million pounds. For ICs, circumstances look poorer, since domestic production of 136.6 million pounds was balanced by a domestic demand of 225 million pounds. Circumstances look especially bad in the case of memories. Here the input quota is 70 percent. Extrapolated to 1982, the position should tend to become worse, although sectoral improvements of the balance sheet may take place.

In a report of the European League for Economic Collaboration, it says that Great Britain enjoys the greatest activity with foreign investors among the states of the Common Market. Thus, in 1980, 59 percent of US investments flowed into the Common Market, and Great Britain received 30 percent of this, a sum of 7 billion pounds. Direct investments of the Japanese for 1979 were specified at 500 million pounds.

SCOTLAND

Scotland is one of the electronic centers of Europe, where mainly enterprises from the USA and Japan have settled. A special agency, the Scottish Development Agency, particularly sees to it to render assistance to companies in establishing themselves and in connection with infrastructural measures. The first phase of the electronic strategy of the SDA was begun in 1979 and was concluded with the expansion of resident multinational enterprises, new domestic investments, the growth of domestic electronic companies, and the newly created 5,500 jobs. The job supply should generally be proved by a selective investment funding program, which is directed toward electronic firms, who want to set up new production, research, and development installations in Scotland. To support this strategy, The SDA has available a budget of 10 million pounds; more public means are available if needed.

Scotland says about itself that it is the "Silicon Valley" of Europe, and this claim appears to be justified since, according to the data of the Commerce Department of the British Legation, in 2 years a considerable portion of the components made in Europe were actually fabricated in Scotland. Altogether more than 40,000 people are employed in the electronics industry (230 companies). In the area of semiconductors, four American and one Japanese enterprise decided during the last 2 years to invest more than 160 million pounds in the expansion or construction of plants.

National Semiconductor

In 1972, NS decided to build up its semiconductor production and development in Greenock. This plant was part of an investment plan to be closer to the European market with an independent plant. In 1979, 45 million pounds were approved to expand this plant from 7500 m² to 30,000 m². Associated with this was a growth of jobs from 650 to more than 2,000. In the new plant section, 5-inch wafers were processed, the only such facility in Europe, because only at NS in Santa Clara are there comparable production installations. In this new plant, circuits can also be fabricated according to customer masks or mask tapes, in the technologies PMOS, metal gate NMOS, isoplanar Si gate NMOS, CMOS, and soon also XMOS and Si gate CMOS. Certain Schottky and LPS components are recently also produced in Greenock according to the CEEC qualifications. About 75 percent of the components fabricated here are exported.

Motorola

The Motorola Plant in East Kilbride comprises three building sections, of which the first two have been completed since 1969 with an investment volume of 60 million dollars. The third section is under construction and requires 120 million dollars. Upon completion, Motorola will have available about 30,000 m² in addition to a leased building on the same terrain of 5,500 m². It will employ about 1300 people.

Ninety percent of the component produced here will go to the European market, and the rest to Japan. HSCMOS, CM(S, and NMOS technologies are available. The emphasis is on CMOS, the HSCMOS process is used both for new logic circuits and for microprocessors.

NEC

In 1981, NEC erected a new plant in Livingston. In its first phase, it employed 200 people. In the later eighties, this figure is to rise to 800. The second construction phase, which also comprises diffusion, will begin in 1984 and will comprise a total of 18,000 m². Upon completion, the plant will be the first Japanese integrated production for 16-bit microprocessors and memory chips. One expects a monthly output of 3 million 64-K chips and microprocessors, although it is possible that, upon completion of the building work, NEC will here manufacture its next 256-K chips. Total investments run to about 40 million pounds, of which the state has contributed about 40 percent.

General Instrument

In May 1981, the cornerstone was laid for a new microelectronics plant of GI in Glenrothes. This plant was fully subsidized. It is to be completed in 1985, and should substantially increase existing capacities. It is equipped with the most modern production facilities and engages about 500 employees. The built-up area is about 4,000 m².

Other activities in the Scott "Silicon Valley" comprise the Hughes Microelectronics (450 employees) and Burr-Brown (first manager). Because of the recession, 3,500 m² in Livingston are occupied, but a production start has not yet been definitely specified.

ENGLAND

Other enterprises in England are ITT (USA), TI (USA), Mullard (NL), INMOS (UK), Ferranti (UK), Plessey (UK), and GEC (UK). As a more recent example, one should mention INMOS.

Inmos

INMOS is an enterprise financed by British starting capital in the amount of 120 million dollars. It has available plants in Newport (UK) and Colorado Springs (USA). Up to now, static RAMs (NMOS) with short access time and low loss power have been produced. The main sales are currently due to 16-K RAMs, but 64-K DRAMs are already available in piece numbers, however. For 1984, the management has set a sales goal of 300 million dollars. With the introduction of new products (microprocessors, including those in CMOS), this goal should be realistic.

IRELAND

Electronics Location File has worked out an expert opinion whose results have recently been published. These results show that many US companies choose as their production site first of all Great Britain, secondly Germany, and thirdly the Republic of Ireland.

In similar fashion as Scotland, Ireland also has an industrial-location agency, the Irish Development Authority (IDA). The IDA is a semi-governmental institution,

which has available an annual budget of 280 million Irish pounds. For new enterprises, the IDA makes available land and commercial buildings under especially favorable conditions. Newly created jobs are also subsidized, and a tax rate of only 10 percent is legally guaranteed until the year 2000. According to IDA data, a total of 120 foreign corporations in 1981 decided to set up their operating sites in Ireland. The investment volume supposedly reached 1.4 billion DM. About 400 million DM was contributed by the IDA. In 1980, 14,000 persons were employed in electronics, and by 1985 this number will go to 30,000.

Up to now, Ireland has been able to win over only Mostek (Dublin) and Analog Devices (Limerick) as significant semiconductor manufacturers. AD occupies 360 employees and has here concentrated its CMOS activities. About 4 million pounds of subsidies will be granted.

ITALY

Several projects are currently in progress to promote new technologies, for instance the information technology plan (50 million DM) or the national plan for space travel (400 million DM).

The trade balance for electronic components is negative. In 1980, the value of imported components was 1.7 billion DM, and exports amounted to 1.3 billion DM. The semiconductor market was estimated at 680 million DM for 1980, and cannot be satisfied by the practically single large manufacturer, SGS-Ates. Although absolute figures have been quoted, the situation of SGS-Ates can nevertheless be evaluated from the following remarks by Pasquale Pistorio, Chief Executive Officer.

Accordingly, the total orders received for the first quarter of 1982 rose more than 40 percent compared to the same period in the previous year. The ratio of orders received to sales is about 1.25 for this period. In 1981, capital expenditures were 24 percent of sales, and this value will also be reached in the current year. By opening four distribution offices in the USA and by erecting an IC development center in the German Central, a better international position is supposed to be achieved.

Besides the cooperation with Zilog (Z 80, Z 8000), a far-reaching contract was concluded with Toshiba, concerning two high-density CMOS technologies. Static CMOS RAMs, CMOS microprocessors, CMOS gate arrays as well as components for special markets stood in the foreground here.

AUSTRIA

In Austria, too, microelectronics has made its entry in terms of production. A recently begun project attempts to extract medium and small businesses concerning the application possibilities of microelectronics. The Consultation and Information Agency for Microelectronics provides consultation in 1-day discussions without charge. With a more extensive consultation, the full consultation costs will be borne by the enterprise beginning with the 13th day while the Department of Interstate Trade makes a large contribution previous to this.

The Provincial Government of Steiermark wants to make available 140 to 150 million ÖS for the planned joint venture of Vöest Alpine and American Microsystems Inc. This money is to be used for the land development for the plant near Graz. AMI has already allocated 2 million dollars in its quarterly report for the partial technology transfer. The enterprise will be called Austria Microsystems International and is supposed to begin producing ICs already at year's end.

In 1980, Siemens opened the VLSI Center in Villach, where by now about 700 million shillings have been invested. However, the Austrian Government holds a majority interest in this enterprise; it likewise has an interest in the adjoining Development Center for Microelectronics GmbH.

With the exception of 1980 production, 16-K DRAMs were fabricated at first; since January 1982, 64-K DRAMs (200 chips per 4-inch wafer) were also produced. Chip production has been continuously increased. By year's end, the capacity of the current plant complex will be exhausted. 720 employees are engaged at the Villach plant.

Final Remark

This quick journey through European semiconductor electronics shows that European enterprises in their totality can also play an important role in the World Market if inter-governmental egoisms and cut-throat competition in Europe could be avoided. The consumer does indeed profit price-wise in the short term from the present situation; in the long term, however, this industry will become insignificant on the World Market unless coordinated efforts on a common-market basis are undertaken.

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ELECTRONICS

BRIEFS

HOW WILL 'NEW AEG' LOOK--The government guarantee for the AEG Telefunken conglomerate in the amount of 1.1 billion DM appears perfect. It seems as though the giant can be saved with about 4 billion DM. What the enterprise will look like in the meantime, and what will come from the financial turbulence, nobody knows. Even the expert accounting opinion provides no directive. There it says that "...the AEG conglomerate, after completing insolvency procedures, can then be regarded as financially reorganized and independently viable in its new form." From this should come an AEG which has shrunk to 62,000 jobs (99,000 at the end of 1981). Eleven thousand jobs will vanish directly, 22,000 fall to disincorporations. But a portion of the attractive AEG components (commentary p 18) are already outside. Olympia obviously is just about to accept another partner: this may be Ericsson. One problem is Olympia's 400 million DM obligations towards AEG and the coverage of current losses. Political quarrels are appearing between lower Saxony and the Federal Government. The province wishes to provide counter surety only if the Federal Government reciprocally participates in the provincial guarantees for the AEG subsidiaries Olympia and Telefunken. Will the transactions prevail through all this poker playing? The insolvency proceeding is expected at the beginning of December, and the reorganization should take about a year. /Text/ /Cologne ONLINE in German
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ENERGY

FIRST RESULTS, PROBLEMS OF FRENCH DEEP GASIFICATION PROGRAM

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[Article by Pierre Gaussens, President of the Executive Committee of the GECS (Research Group for Underground Gasification, made up of the French Coal Company, the French Gas Company, the BRGM [Bureau of Geological and Mining Research] and the IFP [French Petroleum Institute]: "First Results and Problems in the Development of a Deep Coal Gasification Process"]

[Excerpts] The objective of the Underground Coal Gasification Research Group is to develop and master a technology for the gasification of deep coal reserves (1,000 meters and deeper) that are technically and economically not exploitable by classic mining methods.

The principal problem to be solved is related to the very low permeability of the deep coal which makes it necessary to create an artificial connection between the injection and production wells. The method currently used is hydrofracturing. Laboratory and field research is under way to study the possibilities of an electrical connection. Directed drilling in the coal vein shows promise.

Laboratory and pilot site experiments, as well as modeling, are being carried out on the gasification operation. Difficulties related to the spontaneous ignition of the coal and the creation of a backward combustion have been revealed. The various studies should make it possible to explore the factors that might limit the quality of the gas produced or the quantity of coal extracted by doublet.

All of the elements acquired in this way should lead to obtaining criteria for site selection. Knowledge of the natural conditions of a site is thus essential for the decision and the selection of the operating method. This characterization can be obtained by using current exploration methods such as coring, logging, surface geophysics.

The pilot project for underground gasification of coal, under way in the North of France (the Haute-Deule site) is described. Prospects for the future are outlined.

Objective, Process and Key Problems

Objective

On-site gasification of coal has been carried out in the USSR and the United States but only in shallow veins (depth of less than 300 meters). The objective set in France by the Research Group for Underground Gasification (GEGS) is completely different. It is a matter of gasifying the coal in beds on the order of at least 2 meters thick, located at depths (approximately 1,000 meters) that make them rather unattractive for traditional mining operations.

In the long run, the objective of the GEGS is to implement a process on an industrial scale for the production of a substitute for natural gas (SNG) with high heating power (10 kWh/m^3). But, in order to end up with a gas of this quality, it is first necessary to produce an already rich primary gas (on the order of 3 kWh/m^3). Such a primary gas can only be obtained by using a gasifying agent other than air (oxygen with steam, if necessary). As a second step, this primary gas will be enriched at the surface, by methanization.

Description of the Process

Basically, the process includes the following steps:

- Drilling and equipping two wells (in the petroleum sense of the term) at least 60 meters apart down to the coal vein;
- Creation of a permeability connection in the bed sufficient for a gasifying agent to be injected at the rate desired;
- The gasification of the coal with injection of the oxidizer through a well (the injection well) and collection of the gases produced from the second well (production well).

Economic Justification, Sensitivity to Certain Factors

The very specific characteristics of this project have led the GEGS, prior to any work, to verify the economic feasibility of deep gasification for a range of technical parameters that is within reason.

As early as 1977, a first evaluation was made on the basis of the production of rich gas (10 kWh/m^3) obtained by the following operations:

- Underground gasification by injection of oxygen and steam;
- Purification of the gas obtained;

--Transformation of this gas into SNG.

This evaluation, brought up to date at the end of 1981, shows that in order to obtain a gas that can be substituted for natural gas at a cost below 15 cF/kWh, more than 6,000 tons of coal per doublet must be gasified at 1,100 meters, which amounts to separating the two wells of the doublet by a distance of over 60 meters, in the case of a 2-meter vein located at a depth of 1,100 meters with a recovery rate of 70 percent, for example.

This fact led the GEGS to turn its efforts to creating a connection between wells sufficiently far apart (on the order of 60 meters) for the demonstration to be economically valid.

Key Technical Problems

The objective for underground coal gasification in Europe implies extremely strict feasibility conditions, principally because of the depth of beds, and poses three major problems:

—In the process that applies to deep resources that are not exploitable under current conditions by mining techniques, the first difficulty encountered is obtaining a thorough knowledge of the natural conditions of an unknown bed (position of veins, dip, opening, composition, regularity). The decision and the selection of an operating method depend on prior knowledge of these natural factors. The current exploration methods using drilling and surface geophysics are at the limit for solving problems with the required precision, and particular care must be taken in prior geological investigation.

--Since deep coals are practically impermeable, the principal problem is to make a connection between the injection and production wells. Hydrofracturing is a method currently used in the petroleum industry that should make it possible to initiate this connection, if it can be directed between the wells. Another process currently under study consists of making an electrocarbonization by injection of current between two electrodes placed in the coal vein. Another method, directed drilling, appears to offer interesting prospects.* The connections obtained by one or the other of these processes can be improved by setting up controlled combustion of a coal channel around the initial connection.

—During the gasification phase properly speaking, good knowledge of the phenomena involved and of their interactions is indispensable in establishing that the process is being maintained for a sufficient amount of time and that useful products are being obtained within the accepted range of operating parameters.

In order to solve these various problems, the GEGS has undertaken a program that includes:

* Horizontal drilling over several hundred meters carried out on the oil bed of the upper Lacq by Elf Aquitaine, in association with the IFP, provides encouragement in this respect.

--Creation of deep onsite pilot operations to solve successively the various key problems enumerated above;

--Implementation of "field laboratory" experiments where the experiments can be done on coal located at shallow depths, thereby allowing access to the experimental zone through an excavation;

--Experimental laboratory work and theoretical work on the problems of connections and gasification.

Knowledge of the Natural Conditions of the Experimental Site and Characterization of the Underground Reactor

Exploration of a deep experimental site includes four principal steps:

Examination of the Geological Environment of the Site

When the site is in the vicinity of a mining bed, we have information from exploratory work (exploratory drilling, seismic profiles and so forth) and from operational mining work. This information makes it possible to draw preliminary geological sections and to delimit the experimental perimeter.

Creation of Specific Exploratory Drillings

This drilling is done to obtain detailed lithostratigraphic and structural sections of the coal series that will be compared to the existing geological documents. The drilling program, therefore, includes both a systematic coring of the coal veins and their vicinity and an exhaustive series of logs.

Following this exploration, a precise diagnostic is established on the geometry, the continuity and regularity of the coal veins within the experimental perimeter. The data gathered also make it possible to interpret observations later obtained by logging during drilling of the injection and production wells.

Analysis of the Fracturing of the Bedrock

This structural analysis is done on cores taken during drilling and its results are compared, if necessary, to those supplied by observation of neighboring mining operations. This analysis makes it possible to know the directions along which natural fracturing of the coal is the most developed and which are, in principle, the preferred directions for the extension of the fracturing induced by hydraulic means.

Determination of the Geomechanical Properties of the Coal and the Surrounding Formations

For the purpose of connecting the wells by hydrofracturing, knowledge of the hydrological and geotechnical properties of the bedrock, particularly of the state of the onsite stresses--or at least, of the direction of minimum stress--is useful for predicting and modeling the induced-fracturing phenomena.

Small hydraulic fracturing tests can be carried out in wildcat boreholes to determine the estimated direction of induced fractures and to compare it with the directions of natural fracturing.

The results of the various investigations made by logging, coring, hydraulic tests, make it possible to characterize:

--The Coal Vein

The logging makes it possible to precisely determine the vertical distribution of the coal layers. Most significant are the densilogs, resistivity logs, sonic and neutron speed logs, but they must take the actual profile of the well into account.

A sufficient determination of the water and ash content is obtained by the combined use of at least two logs (density and resistivity, for example).

The coal rank can be approached by means of C/O, C/H neutron activation logging, use of the Van Krevelen diagram.

--The Surrounding Formations

Conventional hydraulic tests make it possible to estimate the permeability of the medium and to show the characteristics of watertightness that are useful for the implementation of hydrofracturing.

The sonic log gives the dynamic modules but, on the other hand, the resistance characteristics are currently inaccessible by these methods. These parameters are useful for estimating the stability of the gasification chamber.

--The State of Stress

Besides the methods of hydrofracturing, there are currently no methods for measuring the state of in situ stress from a deep well.

--The Structure of the Bed

Characterization of the structural state is derived from the analysis of the dip measurements coupled with an appropriate sonic log (CMS/Circumferential Micro Sonic by SPE Schlumberger or Darcy-Log from the French Petroleum Institute) for the purpose of deriving structural elements.

Knowledge of the real displacement of the faults encountered can be established from stratigraphic correlations between wells.

In tectonic terrains, the continuity of veins is difficult to show. However, a presumption of continuity in the vicinity of a well is provided by the interpretation of a vertical seismic profile (VSP) done with horizontal offset of the surface sound source. Between two wells, comparison of the inclination data and stratigraphic correlations only supplies an additional presumption of continuity.

In 1982, such a procedure is being used on the Haute-Deule site (near Lens), in the Nord-Pas-de-Calais mining basin. The results obtained will make it possible to select the experimentation zone and to select a coal vein within the range of several veins.

Connection between Wells

Problems with the Connection Between Wells and Research Methods

Gasification of the coal contained in a vein assumes the circulation of a gasifying agent between an injection well and a well for drawing off the gas generated in the vein.

The very low permeability of deep coal, together with a natural cracking that manifests itself along privileged directions, makes it impossible to plan on a natural flow of the gasifying agent from the injection well.

On the other hand, knowing that this flow will take place along certain privileged directions, the problem is either to discover the natural directions or to influence nature and predetermine the flow direction so that it is effectively located along the line of the wells to be connected.

Another important consideration is the injection pressure. For technical and economic reasons, it must be as low as possible. Such a requirement makes it impossible to plan on a pneumatic connection between the wells as a transfer of gases in the natural cracks of the veins; in that would require an injection pressure higher than or above the stress being exercised on these cracks would be required.

In a thin and deep vein, the necessity of establishing circulation of a gas in the coal vein creates a particularly difficult problem.

That is why several processes for connecting the wells have been investigated. The three processes currently being studied are hydrofracturing, electrical connection and directed drilling in the coal vein.

These processes would make it possible to establish a preliminary connection in a vein, but that would probably be insufficient to assure the transfer of a sufficient gas flow at acceptable pressures. That is why it would most often be necessary to improve this preliminary connection by the controlled combustion of a coal channel around the initial connection. A technique called backward ignition has already been successfully used in shallow conditions in American tests and should make it possible to obtain a sufficient connection for the gasification phase.

Hydrofracturing

The connection made by hydrofracturing has been the subject of theoretical work. It is also being studied in the laboratory and has been used experimentally at the pilot site in Bruay-en-Artois (Pas-de-Calais).

At the projected depths, the fractures are vertical, although certain fluid flow surfaces which cut through the principal fracturing can occur horizontally. Consequently, the fractures must be oriented to the azimuth, their height must remain close to the height of the vein and they must have good conductivity.

The direction of hydrofracturing depends on the existing stresses, on the natural cracking in the mass and on the pressure of the fluids contained in the layer. Since the injection and production wells are located along the direction of the cracking, as soon as it is known approximately, the development of a fracture going through the wells can be obtained by simultaneous or alternating injection in the wells.

The method of simultaneous injection has been applied in the field at Bruay-en-Artois. The connection between two wells 60 feet apart in a bed 1,170 meters deep has been obtained, and 40 to 50 percent nitrogen injected into one well has been recovered in the other.

During this test, the technique of hydrofracturing properly speaking was not completely controlled. In fact, each of the wells (injection and production) was fractured but, because of a precocious screenout, only 15 percent of the planned volume of banking sand (10-20 mesh) could be effectively placed in the fractures. Consequently, the conductivity of the connection was insufficient and the transfer pressure of the gas from one well to another remained high (more than 25 MPa), (3,700 psi).

In order to explain the difficulties encountered during this operation, specific research on hydrofracturing of coal has been undertaken. From a theoretical standpoint, the opening of a fracture is modeled by assuming a friction contact between the coal and the surrounding formations. From an experimental standpoint, the erosion of the coal by sand-laden gels is being studied in the laboratory.

The high fracturing pressures encountered in the coal can engender secondary fractures and, in so doing, be the cause of blocking and screenout. Lowering this fracturing pressure depends specifically on a good selection of fracturing fluid. Published research seems to indicate that the use of foam would lead to obtaining better results.

Electroconnection

A permeable channel must be created between the wells to be connected by passing a strong electrical current between the wells. The current provokes physical-chemical transformations of the coal, particularly pyrolysis.

The advantage of the method is that the channel is maintained in the coal. Its disadvantage is that this technique, as it has been practiced to date, requires high electrical currents.

Therefore, the purpose of the research program that has been undertaken is to better understand the electroconnection process in order to improve it, if possible, and to make it usable for wells 60 meters apart.

To this end, various types of tests have been performed:

--On 1:10 blocks, in the laboratory;

--On an outcropping, in an open pit operation;

--In a vein about 30 meters deep, between two wells 10 meters apart, at the pilot site at Echauds (Loire).

The tests on 1:10 blocks have shown that the way the electrical voltage is applied during the test (level, duration, threshold) has a considerable influence on the morphology of the pyrolyzed channel and on the power used during the test. They have produced a preliminary idea of the relationship between the power required and the distance between electrodes.

In the tests on the coal outcropping, the electrodes were approximately 1 meter deep and the connection was attempted for distances between electrodes of 1, 2 and 3 meters. A power of 20 kVa at a maximal voltage of 6 Kv was available. The connection, or the cokefaction, of a channel between the electrodes was obtained for distances between electrodes of 1 and 2 meters. These tests have supplied interesting indications on the temperatures reached and on the relationship between the power required and the distance between electrodes. By extrapolation, these results have made it possible to define the conditions of a test between electrodes 10 meters apart and, specifically, the maximal power to expect.

The test with electrodes 10 meters apart was performed in March 1982. The alternating electrical current supply allowed a maximal power of 2 MW and a maximal intensity of 1,000 A, for a voltage varying from 150 to 6,400 V. The electrodes were in contact with the coal bed over a height of 1 meter. The well equipment allowed the circulation of nitrogen down in the wells and between the two holes. Voltage, intensity, power, potential of the ground around the wellheads, temperatures and pressure in the wells were continuously measured.

A hole drilled 2 meters from one of the electrode wells was used as a measurement well.

The electroconnection was accomplished in 14.5 hours with use of the maximal power of 2 MW available and a total energy of 10 MWh. A very high temperature level was reached (approximately 1,500° C according to observations made on the well equipment). It marked the end of the experiment by destruction of the electrical circuit in the well.

In general, the values of the electrical parameters required for the operation, which had been extrapolated from laboratory tests and small-scale tests, were rectified. The maximal power and the total energy used, however,

were higher than projected. The influence of the surrounding formations, in this case more conductive than the coal, and the tendency to carry out the test at the highest voltage available can explain these results.

An optimization of conditions for the application of the voltage could ultimately increase the duration of the test and would probably make it possible to lower the temperatures and to decrease the maximal power used and, therefore, to control the operation better. New tests will be carried out.

Directed Drilling

If directed drilling maintained in the layer were possible, that would be an effective solution to the problem of the well connection, since it would guarantee a good conductivity and would thus facilitate the backward ignition phase, if it were still necessary.

Drilling from the surface in a coal layer has already been done by the Bureau of Mines, at a depth of 300 meters.

At a greater depth (up to 1,200 meters), an application of the techniques of directed drilling in wells, greatly deviated, is possible.

Technically, it is possible to use the method already used by the Bureau of Mines, which consists of making a sidetrack as soon as the presence of waste indicates that the drilling has gone through the coal layer.

It is also possible to transmit to the surface the measurements of the parameters down in the hole that would indicate the position of the drilling tool in relation to the formations surrounding the vein.

The Gasification Process: Modeling and Experimentation

Spontaneous Ignition

At the depths of 1,000 meters and more being considered by the GECS, the permeability of the coal is very low. A connection by backward ignition cannot be accomplished by permeation circulation. A prior connection by hydrofracturing, the only one done to date, allows a circulation of the oxidizer for an overpressure that is more or less high, depending on the quality of this prior connection. For high pressures and at the temperatures of the coal bed (50° to 60°C), the reactivity to oxygen of the coals currently encountered is sufficiently great to run considerable risks of spontaneous ignition. The latter appears after a period of time that is inversely proportional to the pressure and the oxygen content of the injected gas and the reactivity of the coal. This phenomenon was discovered and taken into account during the experiment at Bruay-en-Artois.

Laboratory tests done on coal powder make it possible to measure the oxydation rate of the coals for various partial oxygen pressures and in the temperature range (70° to 140°C).

The kinetic constants thus obtained, used in more or less elaborate numerical models, make it possible to estimate the time before spontaneous ignition for a given coal and for given conditions, and to classify the coals according to the risk of spontaneous ignition that they present.

For a prior connection with high hydraulic resistance, the risk of spontaneous ignition can possibly be limited by reducing the oxygen content of the gas injected and, therefore, the partial oxygen pressure, but at the expense of reducing the oxygen flow and the chances of maintaining a backward ignition under operating conditions.

Backward Ignition

In a homogenous porous medium, the supply of oxidizer to the combustion zone is effected through permeation. In a compact fractured medium, this supply is localized. The phenomena of thermal containment related to the regression of the combustion front are unchanged. Two extreme situations can be considered, depending on whether the channel formed is considered empty or filled with a porous packing (ash, coke and so forth).

In the first case, the combustion products produce a homogenous outflow by layers. In the second, the porous medium regulates the distributions of rates, temperatures and concentrations. These hypotheses are now being modeled.

The models being elaborated will make it possible to weigh the influence of the oxygen flow rates and concentrations in the gas supply, the level of pressure maintained in the channel, the shape and the regression rate of the combustion front, as well as the dimension of the channel formed.

Parallel to the development of the models, autoclave tests have been performed on coal cores approximately 9 cm in diameter and 25 cm long. The mean regression rates on the front of the backward ignition are approximately 5 cm an hour for an operating pressure of 5 MPa and an air flow of 3 l/min. The study of the influence of the principal parameters (total pressure, flow rate and composition of the gas injected, dimension of the initial channel) is under way.

Gasification

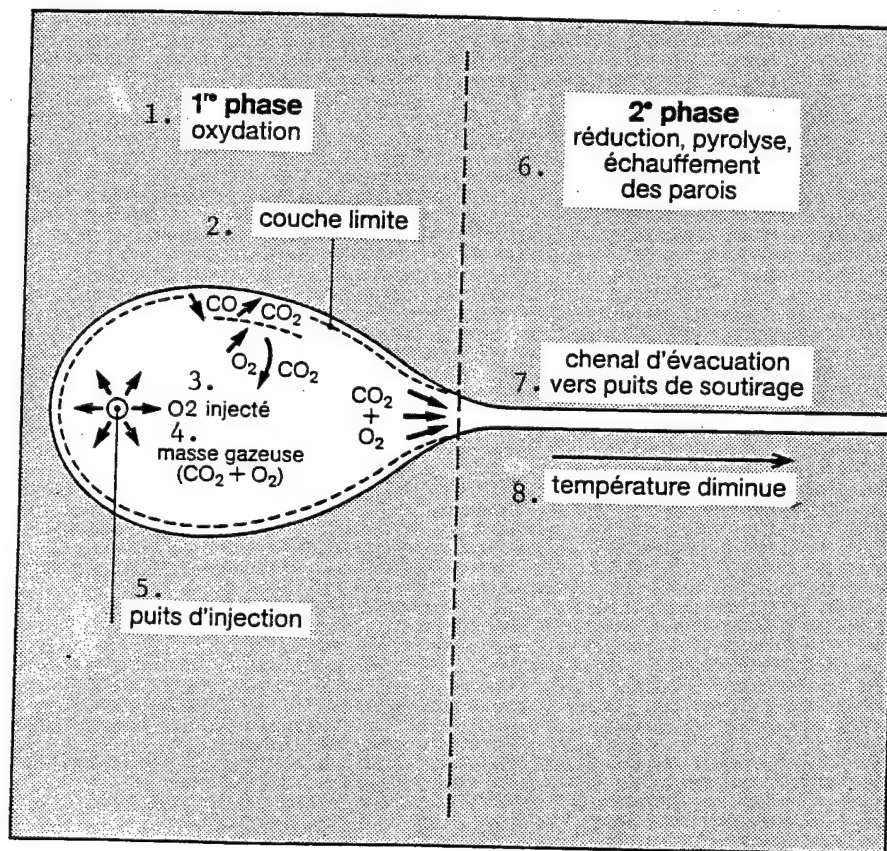
At the base of a well for the injection of gaseous reagents, the coal consumption is considerable. The space thus cleared constitutes a chamber in which, because of the intensity of the transfers on the walls and the slow rates of the pressurized fluids, homogeneity as to concentrations and temperatures is assumed. The products formed in this way are evacuated toward the recovery well through the connecting channel where they continue to react with the coal as long as the conditions encountered allow it.

In addition, the coal consumption, preponderant near the injection well, can bring the reaction chamber to dimensions where the position of the roof of the layer is considerably modified by sagging or caving. These mechanical

phenomena are being studied for the purpose of estimating their ultimate consequences on the operation of the underground gasifier.

Finally, the evacuation channel is subjected to currents of hot gases. The temperature variation of the coal forming the the walls of this channel can become considerable and, at the depths under consideration, cause phenomena of viscoplasticity. Research and experimentation are also being carried out on this subject.

GASIFICATION PROCESS



Key:

1. First Phase: Oxydation
2. Outer layer
3. Injected O₂
4. Gaseous mass (CO₂ + O₂)
5. Injection Well
6. Second Phase: Reduction, pyrolysis, heating of walls
7. Channel for evacuation towards production well
8. Temperature decreases

Consequences of These Research Results for Site Selection

As long as we have only hydrofracturing combined with backward ignition for making the connection between wells, considerations related to spontaneous ignition and backward ignition will be involved in the selection of sites for experimentation.

A given bed is characterized by vein depth and coal quality.

The depth corresponds to a hydrostatic pressure P to which is added an over pressure P for circulation between the wells. The reactivity to oxygen at low temperature and under pressure is a function of the quality of the coal. Depending on the value of the total pressure reached in this way, a maximal oxygen content of the injected fluid is acceptable for a given duration without spontaneous ignition.

The coal under consideration presents a certain reactivity to high temperature oxygen (combustion). In order to maintain a backward ignition supplied by a small channel, at a given oxygen concentration, the supply flow rate must be higher than a certain value.

At a given oxygen concentration, all of the allowable points for backward ignition without spontaneous ignition provide the range of "total supply flow rate pressure" to be obtained for the characteristics of an acceptable connection.

Depending on the quality of the coal and its depth, the chances of reaching a given result can be weighed a priori.

The various models and research relative to gasification should make it possible to explore the factors (depth, flow rate and so forth) that could limit the quality of the gas produced or the quantity of coal extracted per doublet.

French Prospects

The Haute-Deule Program

Since the objective assigned to the Bruay-en-Artois site has been attained, the GEGS is pursuing its onsite experimentation at a new site called La Haute-Deule, located near Lens in the Nord [department] coal basin.

The objective assigned to this new site marks a step forward in research, since:

--In order to reach the coal layers located below 800 meters, the wells are drilled from the surface and no longer from underground sites;

--The layers to reach are made up of a coal with different characteristics from that at Bruay (hard ash instead of bituminous coal).

--The experiments should make it possible to achieve backward ignition at this site and the beginning of co-current gasification.

Work began in 1982 with the drilling of two exploration wells. These two wells should make it possible to select the most appropriate location for the experiment. On the site selected, a second well 60 meters away from the exploratory well will be drilled in the direction that is, priori, the most favorable and a preliminary attempt at minifracturing will be undertaken for the purpose of validating this selection of orientation. If the results of this minifracturing show that there is little chance of establishing a connection between the two wells by large-scale fracturing, drilling of another well in the direction that has proved preferential will be undertaken.

From the operational doubtlet established in this way, the hydrofracturing, ignition and backward ignition will be undertaken.

9969

CSO: 3698/102

INDUSTRIAL TECHNOLOGY

COMPANY FORMED TO MANUFACTURE LASER MACHINE TOOLS

Paris L'USINE NOUVELLE in French 28 Oct 82 p 64

[Article by Patrick Piernaz]

[Text] A message was received from Laser Applications that there are potential sales on the laser machining, welding and cutting markets for those who can offer machines on a turnkey basis.

Reaching a sales volume of Fr 6 million by 1983 is the target set by Laser Applications, a brand new company that has just opened its doors at Baume-les-Dames, near Besancon. This company, a 6-person operation, will make laser drilling, welding and cutting machines. It is entering a market that represents one of the key potential markets of the machine tool sector. American manufacturers, who have widely dominated the market and who have virtually all recorded growth rates exceeding 20 percent per year, are very aware of this.

There is a potential for those who can offer machines on a turnkey basis and intended for specific applications. Such a step enabled Laser Applications to sell its first microdrilling machine to a Korean firm. This equipment automatically drills 4,300 rubies per hour intended for insulators used in electronics. "The drilling quality is what made us win the order," explained Didier Pretor, manager of Laser Applications, "because we are able to drill round holes instead of the usual tapered holes made by laser drilling. The difference between the inside and outside diameter is less than 1/100 mm for a diameter of 7/100 mm and a thickness of 3/10 mm." This machine, which offers a YAG laser source of 300 mJ [as published], can also be used in micro-welding. Meanwhile, Laser Applications has received a second order for more powerful equipment, a laser center drill equipped with a 300 W [as published] head, to be delivered to a subcontractor toward the end of 1982.

A Machine Capable of Cutting 20 Letters Per Second

The second potential market conquered by the small company in Doubs is that of laser cutting. In cooperation with the Soterem Company in Toulouse, it has just been awarded aid from Anvar to develop a machine capable of cutting various parts advancing continuously on a belt at the rate of 20 letters per

second. For this application, Soterem will contribute its skill in the area of pattern recognition and automatic sorting. Its first application could be in aeronautics.

Those in charge of Laser Applications are prepared to deal with the numerous problems of laser machining that manufacturers will inevitably be confronted with. However, their main problem will not be of a technical nature. They will have to finance their growth. It is for this reason that Laser Applications came into contact with companies interested in a capital-risk partnership. An increase of capital is expected in the near future. As of November, this should be followed by a change in the legal structure from the status of a SARL [Limited Liability Company] to that of a business corporation.

12204

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TRANSPORTATION

CITROEN USES NEW MATERIALS, MANUFACTURING TECHNIQUES FOR BX

Paris L'USINE NOUVELLE in French 30 Sep 82 pp 121-124

[Article by Pierre Laperrousaz, Michel Defaux, and Daniel Coue]

[Text] The introduction of a new automobile model is almost always an opportunity for innovation in the vehicle design, in the selection of components and materials, manufacturing techniques, etc. By "dissecting" the Citroen BX, introduced this week at the Porte de Versailles auto show, L'USINE NOUVELLE has made a listing of the new features and most remarkable trends included in this new model. To start its production, 250 million francs had to be invested in modifications, and 600 million francs in specific investments were put into Rennes and 310 million at Caen for the axle manufacture.

First Use of Composites for the Body

In the history of the automobile, the Citroen BX will certainly be remembered as the first European mass-production car to have parts of the body made of composite materials: the hood and the hatchback of the new model are made of polyester reinforced with glass fibers. The hood is molded by compression, and the hatchback by injection.

Citroen, with its new model, is continuing a long tradition of technical innovation. But at the same time, Citroen is not seeking innovation merely for the sake of being new, for there are many reasons justifying this use of composites: weight reduction, simplification of the manufacturing cycle, and excellent resistance to corrosion are just a few of these reasons. The hatchback weighs 8.8 kilos, compared with 10.5 kilos for the back in the GS model, whose size is similar. Even better, it has only three parts (two small reinforcements that are hard to make by molding; these parts must be attached), while the GS hatchback requires the assembly of 27 pieces. "In addition," comments Bernard de Boissieu, who is in charge of body methods,

"it integrates the "rim" that is very hard to make by stamping, and its rigidity, which is greater than that of the sheet metal of the body, means that we can use a thinner piece of glass in the back (3 mm thick instead of 4 mm). This means added weight savings." The engine hood, made in a single piece, weighs 9.23 kilos, compared with 17 kilos for the hood of the GS, which has seven different parts.

This "first" in the use of materials is combined with another first in manufacturing techniques. While the SMC [Sheet Molding Compound] method, used for the hood, has been in use for quite a long time (for end shields, among other things), the molding of the hatchback by the BMC [Bulk Molding Compound] method, using 20 percent glass fibers, makes use of a new technique, developed by SMTP-Billion and Vetrotex (both subsidiaries of SGPM).

Two Minutes to Mold the Hatchback

Called the ZMC, this method combines high injection speeds with a surface aspect of the parts allowing them to be painted in a conventional selection range. More importantly, it does not destroy the glass fibers of the composite to the detriment of the mechanical resistance, which happens with the BMC injection.

The hatchback is made in the Rennes plant on a Billion press with 2,300 tons of closing force. A second machine, being made by an outside supplier, will soon be ready, and eventually a third press will be needed to keep up with the scheduled production rate of 1,000 cars per day. The molding time is about 2 minutes, but Citroen hopes to make this time even shorter. The actual injection takes 1.1 second. "A very rapid injection is essential to obtain a good surface condition," commented Bernard de Boissieu.

After opening the mold, the hatchbacks are removed by handling devices and placed on forms, which rest on wire-guided carts. The two reinforcements are attached manually. The remainder of the manufacturing cycle is entirely automated: drilling, placement of inserts, trimming (to eliminate the humps that had to be included in order to ensure a good fill of the mold), phosphate coating, and application of a primary conductor coating (an electrostatic finishing is then applied). The part is then attached to the car. Between the removal from the mold and the phosphate coating, approximately 10 minutes elapse. This time may be compared with the time required for manufacturing a metal hatchback, which is about 13.5 minutes.

The hood is molded in 2 minutes. "We chose to use compression molding, because the thickness of the part, which is much thinner than the hatchback, made injection difficult," explains Bernard de Boissieu, "but we do have hopes of using injection some day."

The use of composites in the BX is only one aspect of the program designed to lighten the vehicle and improve its resistance to corrosion. Synthetic materials are used in a great many parts. Some are conventional: the dashboard grill, wheel casing, fuel tank, shields (colored in 10 different shades), dashboard control panel, etc. Others are much less so: fuel flap with built-in cap made of polyamide, side mirror made of polycarbonate. This material is highly sensitive to scratching and is protected by a special varnish which was developed by Helic-Ripolin, and polymerized by ultraviolet radiation in a facility built by G2M-Lepetit.

The body contains a large number of HLE [High Yield Steel] parts, making up 14 percent of the mass, and 2 times more parts made of zinc-plated metal (10 percent of the mass) than the GS. The body design (developed by CAO [Computer-Aided Design] has also helped to lighten the vehicle and improve its corrosion-resistance. "Close cooperation between vehicle studies and methods has enabled us to reduce the number of parts, thus decreasing the number of welding points," said Philippe Grundeler, director of general methods. For example, each door consists of two main parts: an external panel and an internal panel which includes the frame (in the conventional design, the frame is inserted). The entire structure has 334 parts instead of the 531 parts used in the GSA and requires 2,676 welding points instead of 5,024. And while the reduction in the number of parts means savings in pressing tools and in the manufacturing cycle, it also helps to reduce weight and the risks of corrosion. In the end, the ratio of mass to square meter of projected surface, which was 42 kilos for the GS (1970) is 32.4 kilos for the BX.

Citroen Wary About Electronics

Control of the engine parameters, optimization of the fuel blend, automatic diagnosis of problems, a number of different alarms, not to mention multiplexing of several electrical functions in a single conductor, possibly an optical fiber: the promises of electronics in automotive design are many, and include improvements in safety and fuel consumption.

But the new Citroen has nothing of all this. Only the ignition is of the Hall-effect type, which eliminates the breaker, a major trouble spot. Why is Citroen being so cautious? The answer given is that electronics would not be as reliable as the so-called conventional mechanical systems, which have proven themselves, and whose research costs have been amortized. But what about the Visa? "In that case, electronics was the lesser of two evils for an air-cooled, two-cylinder vehicle." Obviously, the company is still unhappy about that case, which was expensive and full of problems.

An Intensive Use of Robots

In the Rennes La Janais plant, built in 1960, the metalworking assembly line for the BX body is still working under capacity, producing about 200 vehicles a day. It now has four Kuka spot welding industrial robots. For reasons related to development, increase in production rate, and spreading investment costs over time, the spot welding robots will be added gradually, until the rate of 1,000 vehicles per day is reached.

The introduction of a new vehicle like the BX has brought about a transformation of the metalworking shop which is designed to be a multipurpose facility. The assembly line will be able to handle other vehicles without any major modifications in the manufacturing equipment. It will be enough to reprogram the robots. "These multipurpose assembly lines and this high-performance equipment will now give us the capability, in the PSA group, to juggle our plant production capacities and the models we have to assemble," explained Philippe Grundeler, director of general methods for Citroen. "Then we can have our plants working at optimum capacity."

If we examine the equipment installed following the sequence of the manufacturing cycle, we find first the front end assembly line (10 spot welding robots), the undercarriage assembly line (eight robots to spot weld the finished front end, the floor, and the rear frame), and the body metalworking line (18 robots). On this line, the undercarriages and side panels are placed on carts driven by endless screws and rollers, a system already used in the Citroen plant at Vigo. These carts move from place to place, picking up other parts of the vehicle. The 18 robots to be installed during 1983 will include the four Kuka models that are already operational, two Comau (an example of reuse of robots at Rennes), and the Barnabe robots developed by Talbot and built by PSA.

Robots to be Programmed by CAO Soon

In terms of spot welding techniques, there are no innovations, at least for the time being. "Like all automobile manufacturers, we are working on spot welding control."

The robots will be programmed in a conventional manner on the assembly line. "We have used computer-aided design to check the location of the robots on the lines. The use of CAO for their programming, as presented last June in Paris at the Citroen Mechanical Constructions display, might come about in the very near future," say people in charge of methods. And Rennes might well be the first of the group's facilities to use this new technique.

Other robots have also been installed to meet the requirements of the BX program, particularly in the Caen plant. There are 16 additional ASEA units working on Mag welding. They weld spars, engine mounts, bars, bearing bolts, etc., to produce front axles (nine robots) and rear axles (seven robots). "These are parts which are being modified and changed," points out Richard Gilles, director of general mechanical methods. "The robots make it easier to incorporate the variations sought by our research staff."

Rods Replace Levers

In mechanical terms, the design selected for the BX, if we exclude the retention of its hydropneumatic suspension--the standard Citroen trademark--can only be understood in relation to the strategic evolution of the PSA group in general.

The main objective is to standardize to the maximum degree possible its mechanical elements in order to reap the benefits of scale economies made possible by a huge production. Here we should point out that the introduction of the BX (whose production goals reach a level of 1,000 vehicles a day a year from now), is being accompanied by a complete renovation of the 305: the expected rate of production is 680 trucks per day and 230 vans), to adapt it to a very similar mechanics: a new vehicle designed as an old one!

The engine design selected for the BX is a flagrant example of this, because the 1360 cm³ engine mounted (for the time being) on the cheaper versions (62 and 72 hp DIN) is nothing but the engine used in the Peugeot 104 and Renault 14 which have fallen into disfavor. Furthermore, the new XU 1580 cm³ engine (90 hp DIN) will also be installed in the new 305 GT. The XUD 1905 cm³ diesel engine which is already used in the Horizon Talbot EXD

and LD and the new 305 SRD and GRD will also be used in the diesel version of the BX which will make its appearance in a few months.

It has now become standard practice for the engine to be mounted transversally in order to reduce the amount of space occupied, with the transmission system mounted on its end in order to meet a requirement of interchangeability. It is becoming easier and cheaper to increase the number of "models" by combining engines and transmission systems (four or five speeds, automatic transmission, etc.) or to add more advanced engines or transmission systems to existing cars, as the new systems are developed. This method will gradually spread to all French low and medium-priced vehicles between now and 1985.

"In developing the XU engine, we were guided primarily by the objectives of lightness, reliability, and economy," explained Andre Debladis, who is in charge of the gasoline engine group at the PSA study and research center. Among the technical possibilities chosen, we can mention the direct action of camshaft valves placed "on the head" and rods, which means that levers and rods can be eliminated; this also improves access to the sparkplugs and simplifies the design of the cylinder head. Distribution is handled by a cogged belt, which is lighter than a chain system. So this is an engine of a conventional design, operating with a "poor" fuel blend, and with a transistorized ignition system, but optimized in every possible way, since it weighs only 109 kilos and supplies a power of over 57 hp per liter. In addition, internal standardization has been taken to a very advanced level, since the external fastening points, the rod bearings and bores, and various pieces of equipment, such as the oil pump and crank case are used both in the XU and the XUD, with the latter having a cast metal engine unit.

For the suspension and chassis, the design philosophy is the same. A large number of parts had to be developed to handle either the advanced MacPherson system or the hydropneumatic design. For this reason it may well be that one day there will appear on the market a BX with conventional suspension or a Peugeot or Talbot with hydropneumatic suspension. The marketplace will decide! Parts such as transmissions, hubs, wheel bearings, pins, steering and braking systems are totally interchangeable and can be found on both BX and 305 models. For example, the configuration of the rear chassis of the BX is very similar to that of the 305 van. The Citroen suspension is mounted horizontally as in its Peugeot "sister," in order to increase the volume of usable trunk space.

Still in the rear, the wheel bearings designed and manufactured in France by SKF are of the integrated "second generation" type, with the external ring serving as a hub to which either a brake disk (in the BX) or a brake drum (in the 305) is directly attached. This again indicates a decisive evolution that we will soon see in other models.

7679

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TRANSPORTATION

SNECMA/GE CFM56: ENGINE FOR A NEW AIRLINER GENERATION

Gelsenkirchen AEROKURIER in German Sep 82 pp 1018-1019

[Text] The CFM56, a fan engine of recent technology developed and produced equally as a joint project by General Electric and Snecma, is under discussion for the 150-seat Airbus A320, the four-jet Airbus-Long-range version TA 11 in the planning stage, as well as for possible newly developed Boeing 737 and McDonnell Douglas (e.g., DC-9 and 3301); it has already been selected for the new Boeing 737-300; and fairly large parts of the more recent narrow-body, long-range fleet (DC-8, 707, KC-135) four-jet engine are being changed over to this engine now or will be in the immediate future.

The introduction of this engine in air traffic will result in drastic fuel savings and a corresponding reduction in passenger mile costs. Thanks to the CFM56, aircraft which have been considered economically outdated and unfeasible, such as the DC-8 produced in the 1960's, will be able to compete for years to come with large modern aircraft.

Since the development of a modern engine until it is ready for licensing and production today sometimes takes years longer than the development of a new aircraft, the CFM56 is likely to be predestined for a number of future aircraft projects not available yet. This engine appears to be especially suited for the new 150-seat airliner generation. In its 2K2 version, e.g., the CFM 56 is considered the favorite for the A320.

The CFM56--by June of this year already more than 100 units had been delivered--is presumably only at the beginning of its career. Trusting in the future of this engine, Snecma has initiated one of the biggest investment programs in the history of European engine production, which could make the French engine manufacturer No 1 in Europe and No 3 in the world in the second half of the 1980's.

The CFM56 is a joint product of American General Electric and the French Snecma. Both firms participate equally in the program. General Electric delivers the highly modern "hot" section, based on the F 101 engine designed for the B-1 bomber. Snecma is primarily responsible for the so-called "low-pressure part," i.e., the highly modern single-stage fan with its forged Titan blades--which, by the way, is a Snecma specialty--as well as low-pressure compressors and low-pressure turbines and, last but not least, the thrust reversal.

The CFM56 development is based on two separate project studies, General Electric's GE13 and the M56 by Snecma, both for the 10-ton propulsion class. Common construction goals were, above all, a drastic reduction in fuel consumption and noise and air pollution, with simultaneous simplification of maintenance and lowering of operation costs.

Impulses for the search for a partner came from Snecma. At the end of 1971, a cooperation agreement was reached between Snecma and General Electric about the joint development of the present CFM56. The work was temporarily interrupted in the fall of 1972 through a U.S. export embargo.

Development and testing were done on both sides of the Atlantic. The McDonnell Douglas YC-15, a Boeing 705 and, above all, a modified Aerospatiale Caravelle were used for flight-testing purposes. In 1974, General Electric and Snecma founded CFM International as a joint project cover.

On 8 November 1979, the CFM56 was licensed simultaneously in the United States and in France. At present, there are three versions:

--the CFM56-2--106.8 kN strong and already licensed;

--the CFM56-4--with an increased capacity of 120 kN, in the planning stage; and

--the CFM56-3--having a 89 kN capacity, under development now for the Boeing 737-300. Its fan is like that of General Electric's CF6-80 engine. First test runs for this engine were done in April of this year. Flight tests will be done this coming January. Licensing is planned for September 1983.

The CFM56, which is relatively short, is a two-wave blower engine with direct air-intake without air-intake guide vanes. The key feature for its economy is above all the single-stage fan with its 44 forged Titan blades.

Directly connected to the fan is the three-stage low-pressure compressor. A ring of "bleed doors" (air flaps) diverts excess air to the fan when the engine runs on low. The bypass ratio, that is, the ratio between air passing solely through the fan to "burnt" air, amounts to 6:1 in the CFM56-2, and 5:1 in the CFM56-3.

The nine-stage high-pressure compressor has Titan blades up to the third stage, the rest are made of steel like the stators. The overall compression is 25:1.

The annular combustion chamber is based on the one of the F 101 engine and has been improved for better combustion and reduction of smoke emission. In this respect, the CFM56 is considered the cleanest engine existing at present.

The single-stage high-pressure turbine (inlet temperature 1,260°C) has air-cooled stators and rotor blades.

It is followed by a four-stage low-pressure turbine and the hot jet exit modified for noise reduction. But the fan air exit also has corresponding noise reduction devices.

At this time the CFM56-2 is designed for a starting capacity of 106.8 kN (24,000 lbs). At an altitude of 30,000 feet (9,144 m), the engine running at 0.80 Mach has a capacity of 28.26 kN (6,350 lbs).

The specific fuel consumption of the -2 is 18.4 mg/Ns (0.65 lb/h).

The CFM56 is equally suited for civilian and military retrofit programs. In the civilian sector, the number of potential airliners to be changed over (especially the DC-8 produced in the 1960's) is estimated at 300. Aircraft which are not modified can hardly be flown after 1985, after the new environmental protection guidelines go into effect. The others can be used for scrap only. To overstate: the changing over to the CFM56 results in an airliner which has almost one entire additional life span before it, for the scrap value of the plane, plus the price of four engines. Fuel savings are also the main reason for modifying the KC-135 and KC-135F, both of them tanker planes which are based on the 707 of the U.S. Air Force and the French Air Force. The number of planes involved here cannot even be estimated yet. Nine KC-135's will be modified still this year and 300 additional planes are to follow in the next 5 years. All in all, Air Canada, Capitol Air, Delta, Flying Tigers, the French Air Force, Overseas National Airways, Orion, Southwest, Spantax, Transamerica, United Airlines, US-Air, the U.S. Air Force and four VIP planes have decided in favor of the CFM56. By the end of 1984, according to Snecma's calculations, these carriers will have reached more than 3 million hours of operation with the CFM56.

Commacorp in El Segundo, California, founded in 1977, specializes in the DC-8 modification. As main contractor, the corporation is responsible for negotiations and contracts with the air lines, supplemental flight testing and licensing of modified airplanes. Construction plans for the modification of the DC-8 were worked out by McDonnell Douglas in Long Beach, the modifications themselves are done at McDonnell Douglas' Tulsa plant. Engine gondolas and pylons are delivered by Grumman Aircraft in Bethpage, Long Island, New York.

Not only the economy, but also the capacity of the modified DC-8 is improved, as well as the initial propulsion on high and hot airports, and the range-- which is increased by 800 to 1,000 NM (1,480 to 1,850 km). Initial altitude is also improved by up to 4,000 feet. Noise is reduced 70 percent, clearly exceeding the demands for FAR36 and ICAO Annex 16.

A modified DC-8 from the 1970's will cost between \$55,000 to \$90,000 per seat less than a new airplane. With a 15 to 22 percent reduction of fuel consumption (without any change in the hull), an annual saving of 3.7 to 5.5 million liters (depending on use) is to be expected which--figured over the entire lifespan of the plane--could mean a cost reduction of \$30 to \$40 million. The DC-8 with CFM56-2 also becomes interesting for special purposes (e.g., VIP transport, official missions). It can fly nonstop from Paris to Tokyo, from Honolulu to Jeddah, or from Cairo to Rio de Janeiro. At present, the DC-8s of the French Air Force, among them the president's plane, are modified at UTA Industries in Paris.

The modification will make it possible to keep the DC-8 and 707/KC-135 in service at least way into the 1990's. Without a doubt, this will also have a depressing effect on the market for new small long-range airplanes and is likely to have played a part in the decision to stop the construction of Lockheed Tri Star, and is likely to have some effect on a long-range airbus project.

By the end of this year, 29 DC-8s equipped with CFM56s will be returned to line service. Among the first to decide in favor of the modification are renowned airlines such as United, Delta and Flying Tigers.

General Electric and Snecma also succeeded in an important breakthrough in systems simplification. Compared to other currently available engines with high bypass ratio, the CFM56 has 22 to 51 percent fewer components, an advantage in terms of maintenance and repair.

CFM56-2K2

The newest variation of the CFM56 at present is the 2K2 with 25,000 lbs initial thrust, favored above all for the A 320. This is an improved version of the CFM56-2 produced at present for the DC-8. With the 2K2, CFM International is offering an additional 7 percent reduction of specific fuel consumption. The savings are to be increased on rolling and descent. CFM wants to concentrate on the use of economical technology. The most important data for the 2K2 are:

The 2K2 could be delivered on licensing approximately 48 months after the official program start, but not before September 1986. This would be the earliest possible date for the licensing of the A 320, which is presently still being worked on of course:

Engine construction	1 + 3 + 9 + 1 + 4
Fan diameter	1.73 m
Number of blades	44
Fan/compression	1.64
Bypass ratio	5.6 : 1
Overall compression	30.6
Initial thrust	25,155 lbs
	112 kN
Weight	2,118 kg

The fact that it would be available way before any competitor is an advantage for the 2K2. More than 8 million operation hours of experience will be available at the introduction of the CFM56. Seen in this light, the 2K2 has a good chance of winning the race for the 150-seat engine.

Comparison Between DC-8-71 and -61

Model	DC-8-71	DC-8-61
Engines	CFM56-2-C1	JT3D-3B
Manufacturer	Snecma/GE	Pratt & Whitney
Initial thrust at NN altitude	97.9 kN 22,000 lbs	80 kN 18,000 lbs
Bypass ratio	6 : 1	1.4 : 1
Passengers	212 (18 F/194 Y)	198 (26 F/172 Y)
Crew	3 + 6	3 + 6
Maximum fuel	88,425 l	88,425 l
Maximum armament	74,480 kg	72,575 kg
Maximum load	72,940 kg	74,845 kg
Maximum start weight	147,420 kg	147,420 kg
Productivity at a fuel consumption of more than 1,000 NM: per km, per passenger	32.9	26

Comparison Between Snecma/GE CFM56-2 and -3

Manufacturer	Snecma/GE	
Model	CFM56-2	CFM56-3
Thrust	106.8 kN 24,000 lbs 10,900 kp	89 kN 20,000 lbs 9,070 kp
Bypass ratio	6 : 1	5 : 1
Rate of airflow	375 kg/s	297 kg/s
Mass	2,092 kg	1,940 kg
Fan diameter	1.75 m	1.52 m

9328

CSO: 3698/107

TRANSPORTATION

BRIEFS

AIRBUS FLIGHT SIMULATOR--Airbus Industrie and Thomson-CSF have signed a contract to install a flight simulator for the A300-600 aircraft at Aeroformation. This simulator will be the first developed anywhere in the world for this type of plane. It will be ready for use in training in December 1983 and will handle the qualification of the first A300-600 crews starting in early 1984, thus meeting Airbus Industrie's operational requirements. We should point out the magnitude of the industrial achievement involved in developing a simulator corresponding to an entirely new type of plane in such a short period of time. This has only been made possible through the close and ongoing cooperation that has existed between Thomson-CSF, Aeroformation, Airbus Industrie, and Aerospatiale for a number of years. This simulator will meet the "Phase II" standards of the U.S. FAA, and will include the latest technical improvements developed by Thomson-CSF's simulators division. With this latest order, Thomson-CSF has delivered or is now manufacturing a total of 14 Airbus simulators of all types. [Text] [Paris INFORMATION AERONAUTIQUES ET SPATIALES in French 16 Sep 82 p 4] 7679

ATR-42 STATUS REPORT--The metal fuselage model of the ATR-42 [Regional Transport Aircraft], which is being developed jointly by Aerospatiale and Aeritalia, on 16 September arrived at Aerospatiale's Toulouse plant. This model was developed by Aeritalia in its Pomigliano d'Arco plant near Naples. This model (length: 13.85 m; width: 2.90 m) was joined to the cockpit model on 21 September. During the course of the next 3 months, an integrated team from Aerospatiale and Aeritalia will develop models for the technical outfitting of the plane's airframe, in order to prepare for the installation of systems, of the electricity system, the flight testing equipment, and some features for commercial use. To date, 45 units of the ATR-42 have been ordered. The plane is to make its first flight in the summer of 1984. [Text] [Paris INFORMATION AERONAUTIQUES ET SPATIALES in French 30 Sep 82 p 5] 7679

ROLLS ROYCE '10-TON' ENGINE--Have the negotiations undertaken 10 months ago by Pratt and Whitney, Rolls Royce and the Japanese industry concerning the 10-ton high efficiency engine failed? The silence surrounding this matter and the lack of any specific proposal from the various concerned parties make it seem so. But, all technical considerations aside, it appears above all that the will of the primary contractors of the American automotive industry (who would like a share of at least 51 percent) and the difficulties inherent in the distribution of responsibilities and manufacturing constitute at least a major gamble, if not an insurmountable obstacle. [Text] [Paris AVIATION MAGAZINE INTERNATIONAL in French 15 Nov 82 p 13] 9955

ATTEMPT TO COMMERCIALIZE BAe-146--British Aerospace is currently making considerable efforts to stimulate orders for the regional quadrireactor BAe-146, which will be certified for flight before the end of the year prior to the first deliveries. Up to this point only 12 have been sold with an additional 14 options to purchase. At the end of October, Plane No 5, a 146-100 fitted with 74 seats, undertook a long demonstration voyage through Asia and Australia. A total of 180 hours of flight have been scheduled along with contacts with numerous potential clients. [Text] [Paris AVIATION MAGAZINE INTERNATIONAL in French 15 Nov 82 p 13] 9955

CSO: 3698/112

END